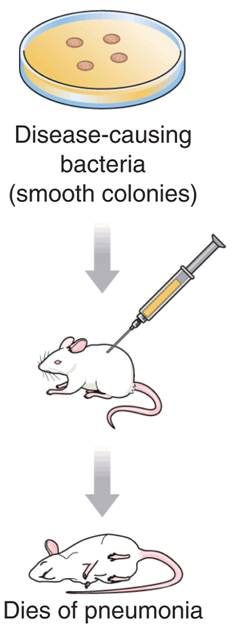
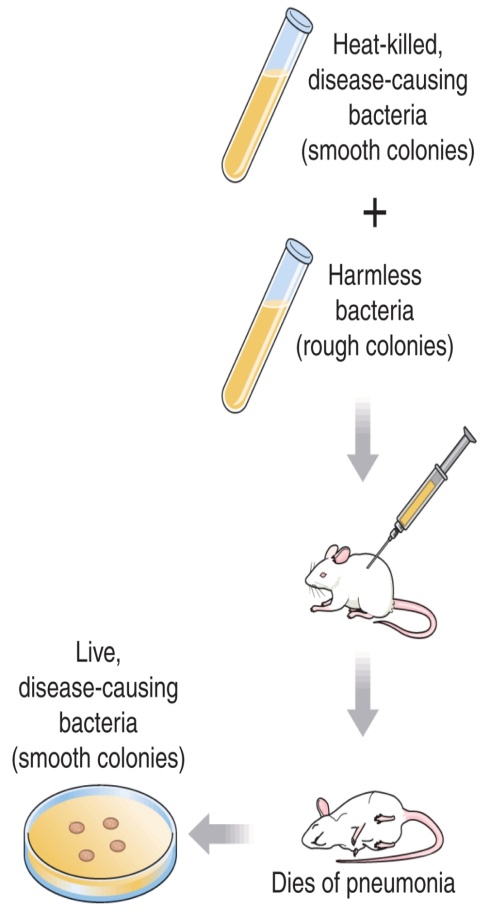
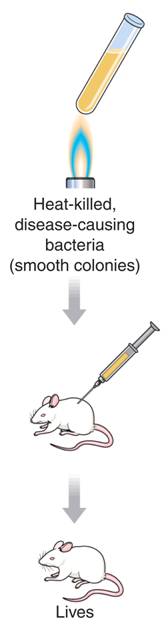
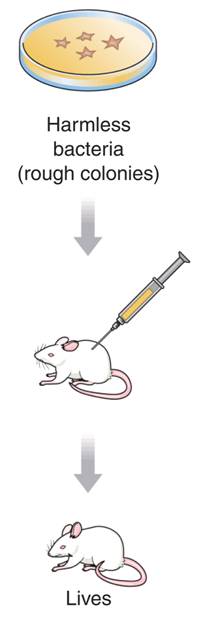
**Chapter 12 – DNA and RNA**

Section 1 – DNA (Part 1)

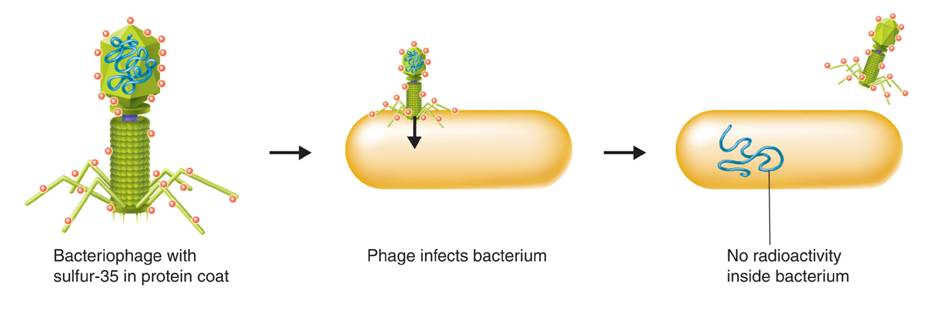
* Griffith and Transformation
  + In 1928, British scientist Fredrick Griffith was trying to learn how certain types of bacteria caused pneumonia.
  + He isolated two different strains of pneumonia bacteria from \_\_\_\_\_\_\_\_\_\_\_\_\_ and grew them in his lab.
  + Griffith made two observations:
    - (1) The disease-causing strain of bacteria grew into \_\_\_\_\_\_\_\_\_\_\_\_\_ colonies on culture plates.
    - (2) The harmless strain grew into colonies with \_\_\_\_\_\_\_\_\_\_\_\_\_\_ edges.
* Griffith's Experiments
  + Griffith set up four individual experiments.
    - Experiment 1: Mice were injected with the disease-causing strain of bacteria. The mice developed pneumonia and \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - Experiment 2: Mice were injected with the harmless strain of bacteria. These mice didn’t get \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - Experiment 3: Griffith \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the disease-causing bacteria. He then injected the heat-killed bacteria into the mice. The mice survived.
    - Experiment 4: Griffith mixed his heat-killed, disease-causing bacteria with live, harmless bacteria and injected the mixture into the mice. The mice developed pneumonia and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

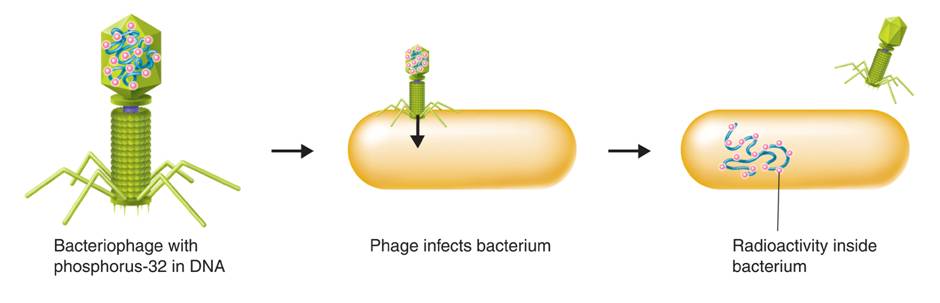


* Griffith concluded that the heat-killed bacteria \_\_\_\_\_\_\_\_\_\_\_\_\_\_ their disease-causing ability to the harmless strain.
* Transformation
  + Griffith called this process **transformation** because one strain of bacteria (the harmless strain) had \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ permanently into another (the disease-causing strain).
  + Griffith hypothesized that a factor must contain information that could change harmless bacteria into disease-causing ones.
* Avery and DNA
  + Oswald Avery repeated Griffith’s work to determine which molecule was most important for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Avery and his colleagues made an extract from the heat-killed bacteria that they treated with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The enzymes destroyed proteins, lipids, carbohydrates, and other molecules, including the nucleic acid RNA.
    - Transformation still \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Avery and other scientists repeated the experiment using enzymes that would break down \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + When DNA was destroyed, transformation **DID NOT** occur. Therefore, they concluded that DNA was the transforming factor.
* What did scientists discover about the relationship between genes and DNA?
  + Avery and other scientists discovered that the nucleic acid DNA stores and transmits the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ information from one generation of an organism to the next.

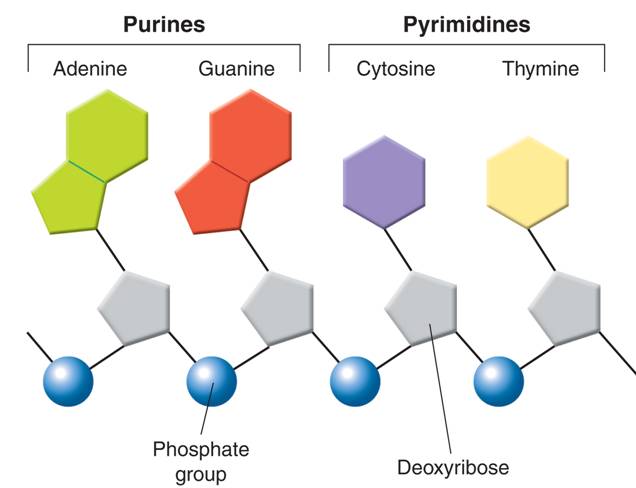
Section 1 – DNA (part 2)

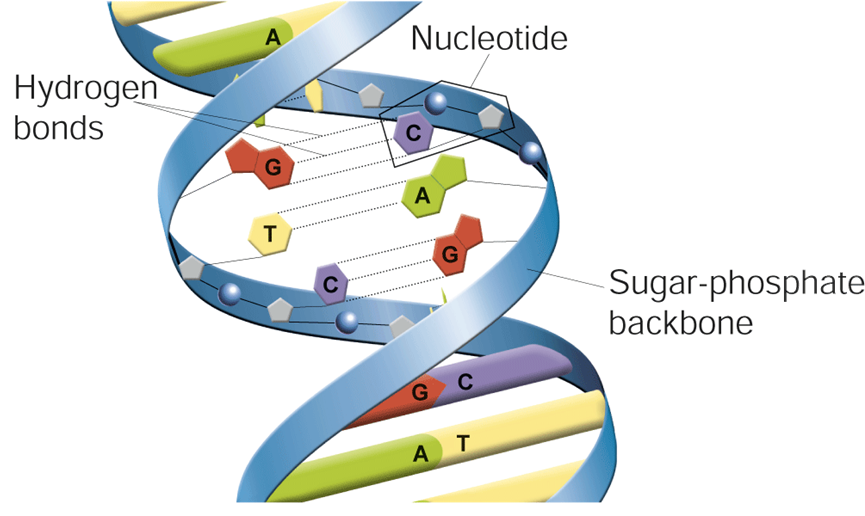
* The Hershey-Chase Experiment
  + Alfred Hershey and Martha Chase studied \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_—nonliving particles smaller than a cell that can infect living organisms.
  + Bacteriophages
    - A virus that infects bacteria is known as a **bacteriophage.**
    - Bacteriophages are composed of a DNA or RNA core and a protein coat.
    - When a bacteriophage enters a bacterium, the virus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to the surface of the cell and injects its genetic information into it.
    - The viral genes produce many new bacteriophages, which eventually \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the bacterium.
    - When the cell splits open, hundreds of new viruses burst out.
  + If Hershey and Chase could determine which part of the virus \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ an infected cell, they would learn whether genes were made of protein or DNA.
  + They grew viruses in cultures containing radioactive isotopes of phosphorus-32 (32P) and sulfur-35 (35S).
  + If 35S was found in the bacteria, it would mean that the viruses’ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ had been injected into the bacteria.

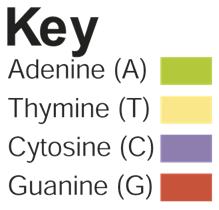


* + If 32P was found in the bacteria, then it was the \_\_\_\_\_\_\_\_\_\_\_\_ that had been injected.
* Nearly all the radioactivity in the bacteria was from phosphorus (32P).
* Hershey and Chase concluded that the genetic material of the bacteriophage was \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, not protein.

Section 1 – DNA (Part 3)

* What is the overall structure of the DNA molecule?
* The Components and Structure of DNA
* DNA is made up of **nucleotides**.
  + A nucleotide is a monomer of nucleic acids made up of a five-carbon sugar called deoxyribose, a phosphate group, and a nitrogenous base.
* There are \_\_\_\_\_\_\_\_\_\_\_ kinds of bases in in DNA:
  + adenine
  + guanine
  + cytosine
  + thymine
* The backbone of a DNA chain is formed by sugar and phosphate groups of each nucleotide.
  + The nucleotides can be joined together in any \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Chargaff's Rules
  + Erwin Chargaff discovered that:
    - The percentages of guanine [G] and cytosine [C] bases are almost \_\_\_\_\_\_\_\_\_\_\_\_\_ in any sample of DNA.
    - The percentages of adenine [A] and thymine [T] bases are almost \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in any sample of DNA.
* X-Ray Evidence
  + Rosalind Franklin used \_\_\_\_\_\_ diffraction to get information about the structure of DNA.
  + She aimed an X-ray beam at concentrated DNA samples and recorded the scattering pattern of the X-rays on film.
* The Double Helix
  + Using clues from Franklin’s pattern, James Watson and Francis Crick built a model that explained how DNA carried information and could be copied.
  + Watson and Crick's model of DNA was a double \_\_\_\_\_\_\_\_\_\_\_\_\_\_, in which two strands were wound around each other.

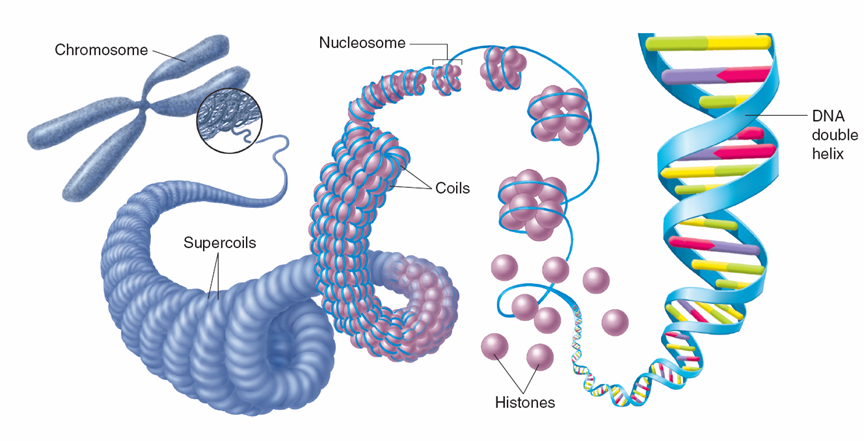




* Watson and Crick discovered that hydrogen bonds can form only between certain base pairs—adenine and thymine, and guanine and cytosine.
* This principle is called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pairing**

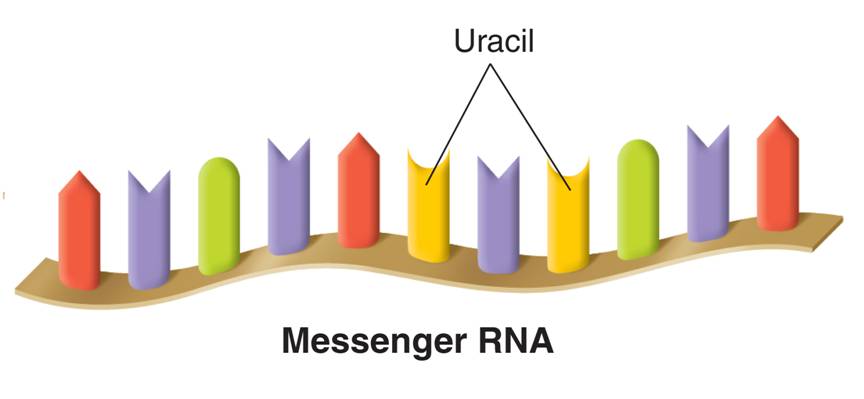
Section 2 – Chromosomes and DNA Replication

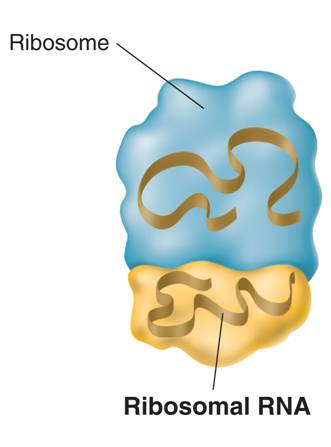
* DNA and Chromosomes
  + In prokaryotic cells, DNA is located in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
    - Most prokaryotes have a single DNA molecule containing nearly all of the cell’s genetic information.
  + Many eukaryotes have \_\_\_\_\_\_\_\_\_\_ times the amount of DNA as prokaryotes.
    - Eukaryotic DNA is located in the cell nucleus inside chromosomes.
    - The number of chromosomes varies widely from one species to the next.

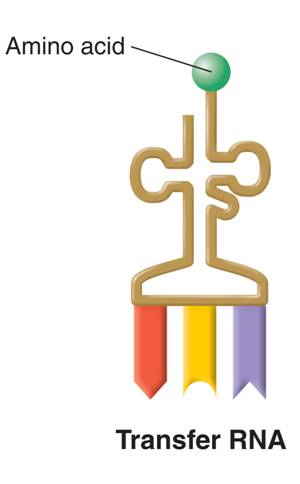


* What happens during DNA replication?
* DNA Replication
  + Each strand of the DNA double helix has all the information needed to reconstruct the other half by the mechanism of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ pairing.
  + In most prokaryotes, DNA replication begins at a \_\_\_\_\_\_\_\_\_\_\_ point and continues in two directions.
  + In eukaryotic chromosomes, DNA replication occurs at hundreds of places. Replication proceeds in both directions until each chromosome is completely copied.
    - The sites where separation and replication occur are called replication \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Duplicating DNA
  + Before a cell divides, it duplicates its DNA in a process called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
    - Replication ensures that each resulting cell will have a complete set of \_\_\_\_\_\_\_\_.
* How Replication Occurs
  + DNA replication is carried out by enzymes that “\_\_\_\_\_\_\_\_\_\_\_\_\_” a molecule of DNA.
  + Hydrogen bonds between base pairs are broken and the two strands of DNA unwind.
  + The principal enzyme involved in DNA replication is **DNA \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.**
  + DNA polymerase joins individual nucleotides to produce a DNA molecule and then “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” each new DNA strand.

Section 3 – RNA and Protein Synthesis

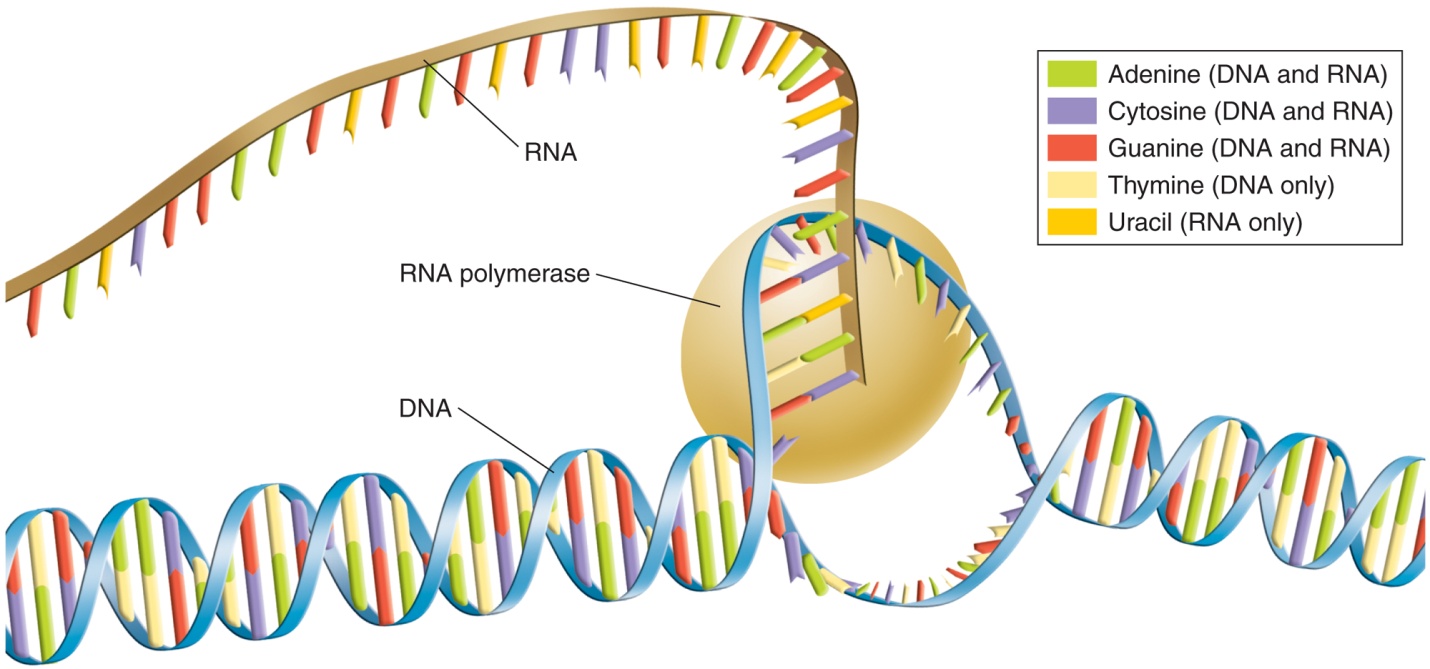
* **Genes** are coded DNA instructions that control the production of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Genetic messages can be decoded by copying part of the nucleotide sequence from DNA into RNA.
  + RNA contains coded information for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ proteins.
* The Structure of RNA
  + RNA consists of a long chain of nucleotides.
  + Each nucleotide is made up of a 5-carbon sugar, a phosphate group, and a nitrogenous base.
* There are three main differences between RNA and DNA:
  + The \_\_\_\_\_\_\_\_\_\_\_ in RNA is ribose instead of deoxyribose.
  + RNA is generally \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_-stranded.
  + RNA contains \_\_\_\_\_\_\_\_\_\_\_\_ in place of thymine.
* What are the three main types of RNA?
  + **Messenger RNA** (mRNA) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ copies of instructions for assembling amino acids into proteins.
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are made up of proteins and **ribosomal RNA** (rRNA).

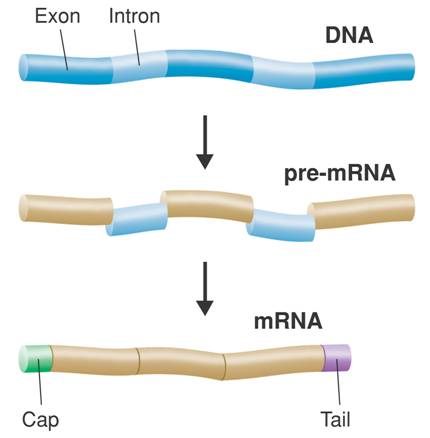
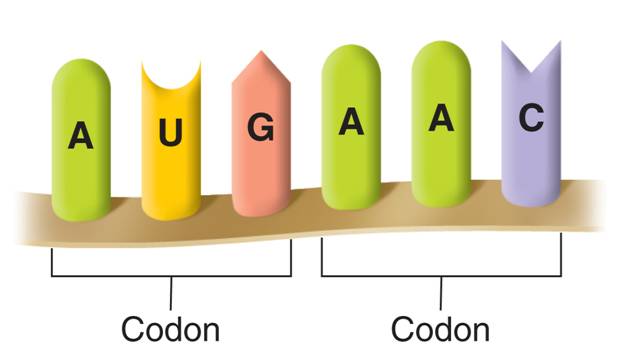


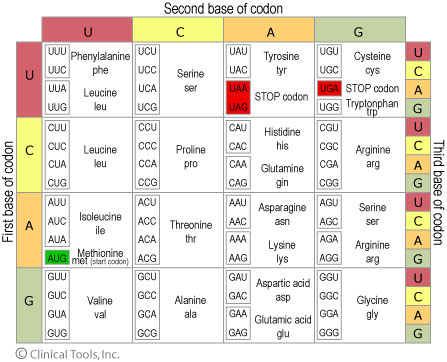
* + During protein construction, **transfer RNA** (tRNA) \_\_\_\_\_\_\_\_\_\_\_\_\_ each amino acid to the ribosome.

Section 3 – RNA and Protein Synthesis (Part 2)

* What is transcription?
* Transcription
  + RNA molecules are produced by copying part of a nucleotide sequence of DNA into a complementary sequence in RNA. This process is called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + Transcription requires the enzyme **\_\_\_\_\_\_\_ polymerase**.
  + During transcription, RNA polymerase binds to DNA and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the DNA strands.
  + RNA polymerase then uses one strand of DNA as a template from which nucleotides are assembled into a strand of RNA.
  + RNA polymerase binds only to regions of DNA known as **promoters.**
  + Promoters are \_\_\_\_\_\_\_\_\_\_\_\_\_\_ in DNA that indicate to the enzyme where to bind to make RNA.

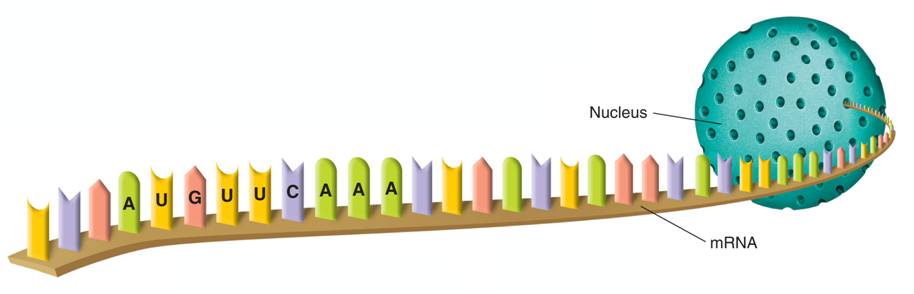


* RNA Editing
  + The DNA of eukaryotic genes contains sequences of nucleotides, called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**, that are not involved in coding for proteins.
  + The DNA sequences that code for proteins are called **\_\_\_\_\_\_\_\_\_\_\_\_\_**.
  + When RNA molecules are formed, introns and exons are copied from DNA.
  + The introns are cut \_\_\_\_\_\_\_\_\_\_\_\_\_\_ of RNA molecules.
  + The exons are the spliced together to form mRNA.
* The Genetic Code
  + The genetic code is the “\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” of mRNA instructions.
  + The code is written using four “letters” (the bases: A, U, C, and G).
  + A **codon** consists of \_\_\_\_\_\_\_\_\_\_\_\_\_ consecutive nucleotides on mRNA that specify a particular amino acid.
* Each codon specifies a particular amino \_\_\_\_\_\_\_\_\_\_ that is to be placed on the polypeptide chain.
* Some amino acids can be specified by more than one codon.



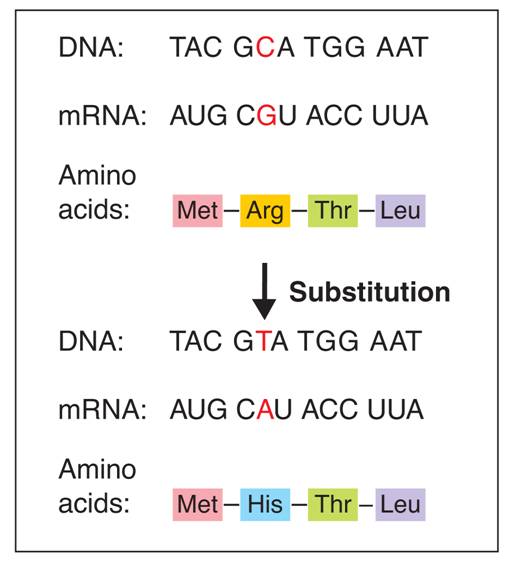
* There is one codon AUG that can either specify the amino acid methionine or serve as a “\_\_\_\_\_\_\_\_\_\_\_\_\_” codon for protein synthesis.
* There are three “\_\_\_\_\_\_\_\_\_\_\_\_\_” codons that do not code for any amino acid. These “stop” codons signify the end of a polypeptide.

Section 3 – RNA and Protein Synthesis (Part 3)

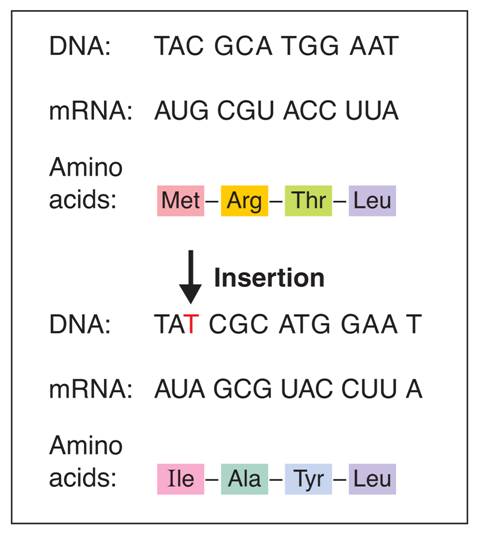
* Translation
  + Translation is the decoding of an mRNA message into a \_\_\_\_\_\_\_\_\_\_\_\_\_ (polypeptide chain).
  + Translation takes place on ribosomes.
  + During translation, the cell uses information from messenger RNA to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Steps of Translation
  + Messenger RNA is transcribed in the nucleus, and then enters the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ where it attaches to a ribosome
  + Translation begins when an mRNA molecule attaches to a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + As each codon of the mRNA molecule moves through the ribosome, the proper amino acid is brought into the ribosome by tRNA.
  + In the ribosome, the amino acid is transferred to the growing polypeptide chain.
  + Each tRNA molecule carries only \_\_\_\_\_\_\_\_\_\_\_ kind of amino acid.
  + In addition to an amino acid, each tRNA molecule has three unpaired bases.
  + These bases, called the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**, are complementary to one mRNA codon.
  + The ribosome binds new tRNA molecules and amino acids as it moves along the mRNA.
  + The process continues until the ribosome reaches a stop codon.
* The Roles of RNA and DNA
  + The cell uses the DNA “master plan” to prepare RNA “blueprints.” The DNA stays in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + The RNA molecules go to the protein building sites in the cytoplasm—the ribosomes.
* Genes and Proteins
  + Genes contain instructions for assembling proteins.
  + Many proteins are \_\_\_\_\_\_\_\_\_\_\_\_, which catalyze and regulate chemical reactions.
  + Proteins are each specifically designed to build or operate a component of a living cell.
  + The sequence of bases in DNA is used as a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for mRNA.
  + The codons of mRNA specify the sequence of amino acids in a protein.

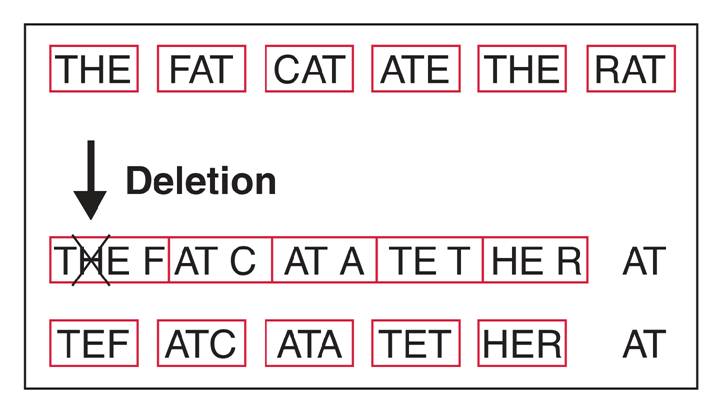
Section 4 – Mutations

* What are mutations?
  + Mutations are changes in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ material.
* Kinds of Mutations
  + Mutations that produce changes in a single gene are known as \_\_\_\_\_\_\_\_\_ mutations.
  + Mutations that produce changes in whole chromosomes are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mutations.
* Gene Mutations
  + Gene mutations involving a change in one or a few nucleotides are known as **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mutations** because they occur at a single point in the DNA sequence.
  + Point mutations include substitutions, insertions, and deletions.
* Substitutions
  + Substitutions usually affect no more than a \_\_\_\_\_\_\_\_\_\_\_\_\_\_ amino acid.



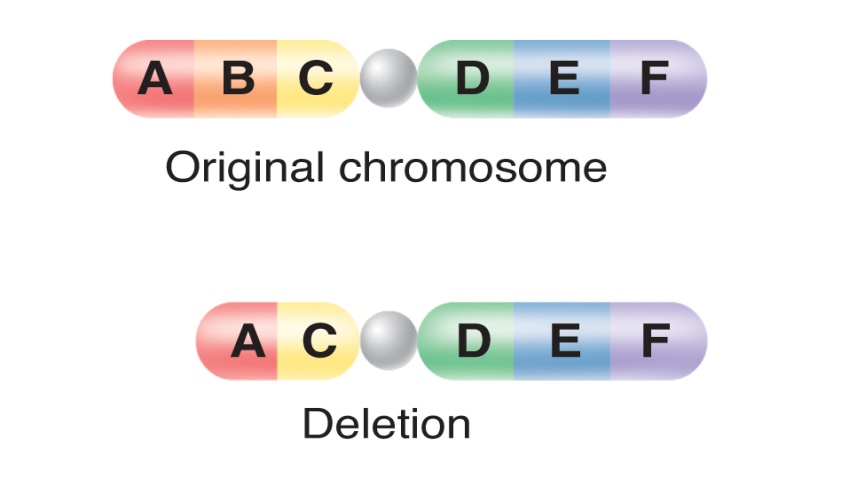
* Insertions and Deletions
  + The effects of insertions or deletions are more dramatic.
  + The addition or deletion of a nucleotide causes a shift in the grouping of codons.
  + Changes like these are called **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mutations.**
* Frameshift Mutations
  + Frameshift mutations may change \_\_\_\_\_\_\_\_\_\_\_\_\_ amino acid that follows the point of the mutation.
  + Frameshift mutations can alter a protein so much that it is unable to perform its normal \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Insertions
  + In an insertion, an extra \_\_\_\_\_\_\_\_\_\_\_\_\_\_ is inserted into a base sequence.



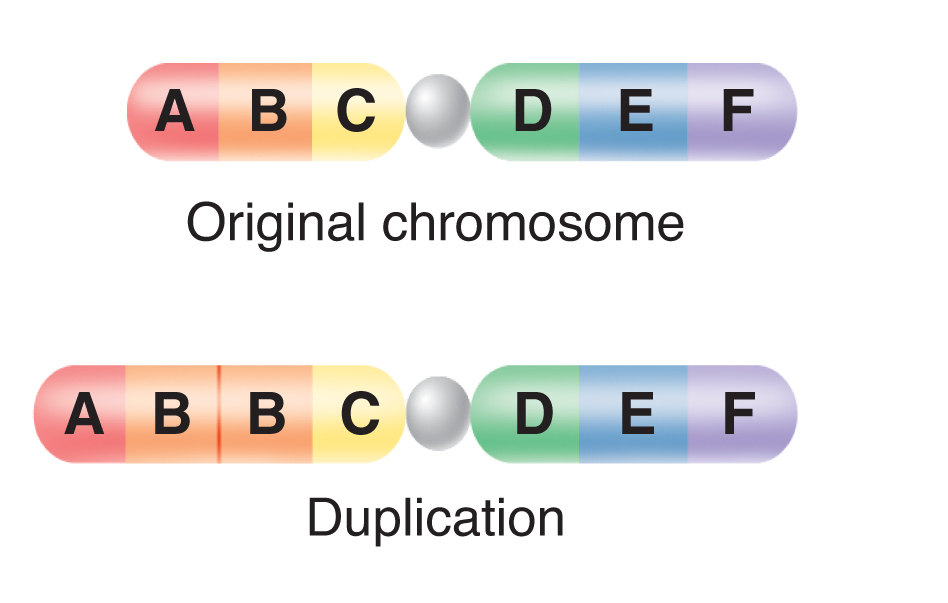
* Deletions
  + In a deletion, the loss of a single base is \_\_\_\_\_\_\_\_\_\_\_\_ and the reading frame is shifted.

Section 4 – Mutations (Part 2)

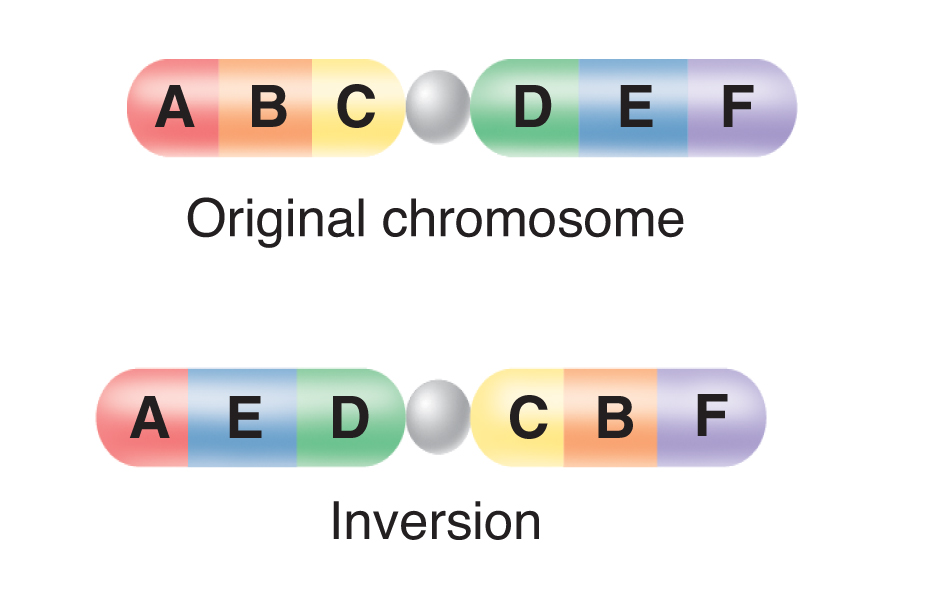
* Chromosomal Mutations
  + Chromosomal mutations involve changes in the number or structure of chromosomes.
  + Chromosomal mutations include deletions, duplications, inversions, and translocations.
* Deletions involve the loss of all or part of a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

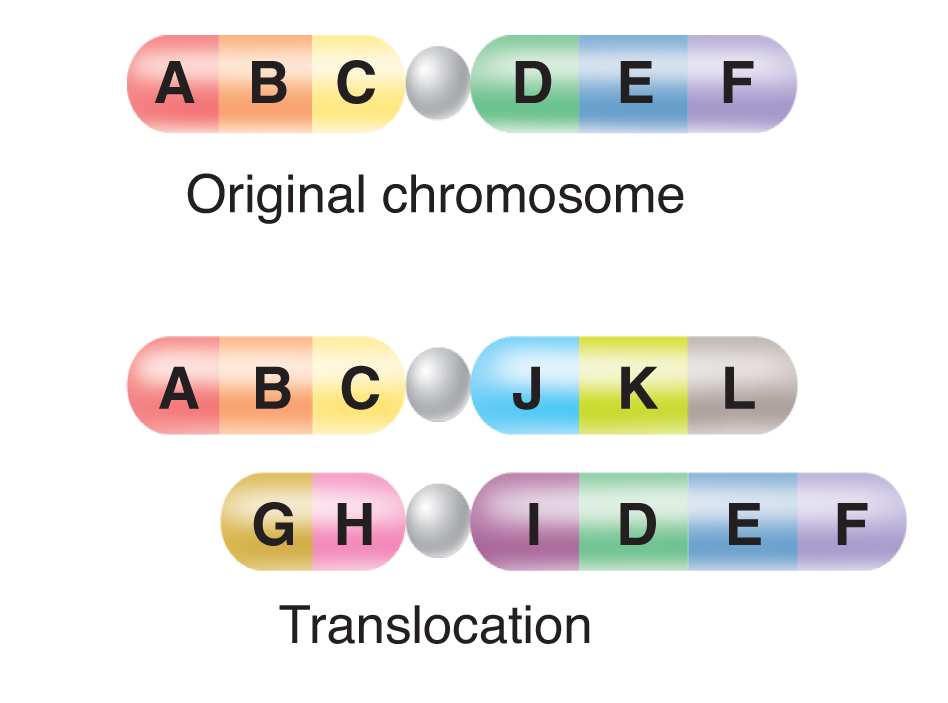


* Duplications
  + Duplications produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_ copies of parts of a chromosome.



* Inversions
  + Inversions \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the direction of parts of chromosomes.



* Translocations occurs when part of one chromosome breaks off and\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to another.
* Significance of Mutations
  + Many mutations have little or \_\_\_\_\_\_\_\_\_\_ effect on gene expression.
  + Some mutations are the cause of genetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
  + Beneficial mutations may produce proteins with new or altered activities that can be useful.
  + **Polyploidy** is the condition in which an organism has extra sets of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.