DNA PARTS

DNA is a polymer. Monomer units of DNA are nucleotides, and polymer are polynucleotide. Each nucleotide consists of a 5-carbon sugar (deoxyribose), a nitrogen containing base attached to the sugar, and a phosphate group. 4 different types of nucleotides found in DNA, differing only in the nitrogenous base. The four nucleotides are given 1 letter abbreviations as shorthand for the four bases.

A is for adenine
G is for guanine
C is for cytosine
T is for thymine

Purine Bases: Adenine and guanine. Purines are the larger of the two types of bases found in DNA.
Pyrimidine Bases: Cytosine and thymine. 6 stoms (4 carbon, 2 nitrogen) are numbered 1-6. Like purines, all pyrimidine ring atoms lie in the same plane.

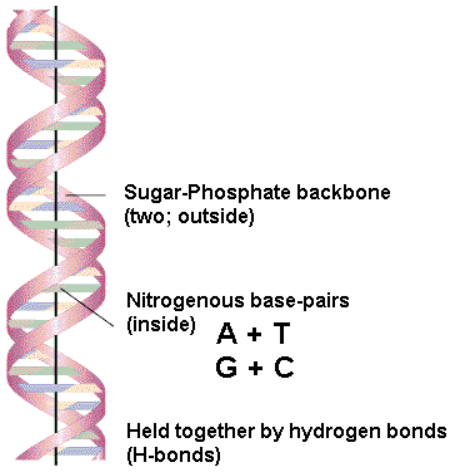
3' AND 5' ON A DNA STRAND

The locations of the sugar and the phosphate give nucleotides heads and tails, two distinct ends. The heads-tails (or in this case, 5'-3') orientation applies here. This head-to-tail arrangement is called *antiparallel,*which is a fancy way of saying the strands run in opposite directions. Part of the reason the strands must be oriented this way is to guarantee that the dimensions of the DNA molecule are even along its entire length. If the strands were put together in a parallel arrangement, the angles between the atoms would be all wrong, and the strands wouldn't fit together.

SCIENTISTS

1. **Griffith:** 1928, **Frederick Griffith** performed an experiment using **pneumonia** bacteria and mice. This was one of the first experiments that hinted that DNA was the genetic code material.
    a. Used two strains the S strain (smooth) R strain (rough)
    b. Griffith was the first to talk about transformation because one type of bacteria had been changed permanently into another bacteria.
2. **Avery: Transformation**: Process where 1 strain of a bacterium absorbs genetic material from another bacteria and turns into the type of bacterium whose genetic material it absorbed.
    a. Took Griffith's base experiment, and concluded that DNA is the transformation factor because when they destroyed DNA in mixture, transformation did not occur.
3. **Hershey and Chase**: Hershey chase experiment, bacterial viruses, bacteriophage, used to demonstrate DNA is the genetic material. The phage used consisted of a DNA molecule, surrounded by a protein coat. When phage infect bacteria, they attach to the surface of the bacterium and inject the DNA into the cell. The protein coat remains on the outside of cell. In the 1st part of experiment, the phage were produced in a medium containing 35s radioactively labeled amino acids. This resulted in a phage population with 35 s labeled proteins but no radioactive signature in the DNA. The radioactive phage infected the cell and the protein coat stayed outside the cell. DNA went and created regular, non radioactive phages in cell. 2nd part of experiment phage produced in a medium containing 32P-labeled deoxyribonucleotides. this resulted in radioactive DNA and then it infected the cell leaving radioactive bacteriophages in it.

a. Used bacteriophage, because it only contained DNA and Protein so nobody can say that there was something else to influence it.
b. If they found radioactive phosphate, they would know DNA was hereditary material, if they found sulfur, th would know it was protein. Found phosphate- DNA.



4. <u>Watson and Crick</u>-

- Purine opposite a pyrimidine
- Chains held together by **H**ydrogen-bonds
  - Guanine is paired with cytosine by three **H**-bonds
  - Adenine is paired with thymine by two **H**-bonds
- Anti-parallel orientation of the two chains
- They see the top of Franklin's pictures, and they know that DNA contains a double helix
- **1953- Structure of DNA is found by them.**

5'---------->3'

3'<----------5'

5. **Rosalind Franklin**: Photograph giving watson and crick the idea for the structure.
   a. Takes an X-Ray diffraction pic of DNA
   b. Saw DNA as a circle from the top
6. **Erwin Chargaff:** Discovered 2 rules on the basis of which we were able to figure out that the DNA had a double helical structure. 1st rule was that DNA had equal percentage of Adenine and Thymine, and equal percentage of Guanine and Cytosine. 2nd rule was that the above mentioned pairs were always paired with each other and could not be cross paired
7. Beadle and Tatum
   a. Originally use fruit flies, but change it to bread mold
   b. Take bread mold and eradicate it with X rays
   c. Mold could not grow on minimal medium, but add 1 nutrient, and the mold could grow.
   d. Found out that 1 gene corresponds with one protein- All enzymes are proteins, but not all proteins are enzymes.

Protein Why It Was Hereditary: Protein originally thought to be genetic material as of its complexity, protein is made up 20 different amino acids while DNA only consists of 4 bases. This was logical as the complexity would account for diversity in organisms.

DNA REPLICATION

DNA Helicase: Enzyme that unwinds the DNA double helix at an AT- rich area

DNA Polymerase: Enzyme that matches new nucleotides to now single strands of DNA

Ligase: Enzyme that attaches Okazaki fragments/edits DNA to make sure there are no problems

Parent Strand: Helix of the new DNA which came from the original double helix

Okazaki fragment: Small piece of DNA on the lagging strand

Leading strand: The helix going in 5'-3' direction, that is with the helicase. DNA is built straight

Lagging strand: Helix going in the 3'-5' direction against the helicase, Okazaki fragments are created
Replication fork- where the two helices of DNA split into a bubble when replication takes place
Daughter strand: The 'new' strand of DNA in replication
RNA primer: Prepares strand to be replicated,shows DNA polymerase where to go, where to start
Semi conservative: When 2 strands of DNA become 4 strands after replication the new double helix's will have a new one and a old one
Codon: Set of 3 nitrogenous bases that represents an amino acid, order of nitrogenous bases determines the type and order of amino acids in a protein
Leading Strand: Strand in which elongation process continuously proceeds in the 5' and 3' direction.
Lagging Strand: Strand is manufactured more slowly than leading strand. DNA polymerase adds nucleotides in fragments/Okazaki Fragments which are spliced together by the enzyme DNA ligase.

<u>There are 4 main stages:</u>

1. Initiation: When a portion of the double helix is unwound.
2. Elongation: When two new strands of DNA are assembled.
3. Termination: When the new DNA molecules re-form into helixes.
4. Proofreading and Correction: Occurs throughout the process to minimize the errors that may occur.

Key Enzymes in DNA replication:

ENZYME GROUP	FUNCTION
Helicase	Cleaves and unwinds short sections of DNA ahead of the replication fork.
DNA Polymerase	Serves 3 different functions: 1. Adds new nucleotides to 3' end of elongating strand. 2. Dismantles RNA primer. 3. Proofreads base pairings
DNA Ligase	Catalyzes the formation of phosphate bridges between nucleotides to join Okazaki Fragments.
Primase	Synthesizes an RNA primer to begin the elongation process.

Stage 1: *Initiation*: Process of replication begins in the DNA molecules at thousands of sites called origins of replication. After a replication bubble has been opened, molecules of an enzyme called DNA polymerase insert themselves into the space between the two strands. Helix begins to pull apart or unwind with the help of helicase.. As unwinding continues, they move in opposite directions creating two Y-shaped replication forks.

<u>Stage 2</u>- Elongation

- DNA polymerase attaches new nucleotides to the free 3' hydroxyl end.
  - First, replication can only take place in the 5' and 3'
  - Short strand of RNA known as a primer must be available to serve as the starting point for the attachment of new nucleotides

Okazaki Fragments. These fragments occur during the elongation of the daughter DNA strand that must be built in the 3' to 5' direction (lagging strand)

<u>Stage 3</u>- Termination

DNA	RNA
• contains 5 carbon sugar deoxyribose • double stranded molecule • ACGT	• contains 5 carbon sugar ribose • single strand molecule • ACGU

Once the new strands are complete, the daughter DNA molecules rewind automatically back to their original helix structure.

Stage 4- Proofreading:DNA polymerase excises incorrect base and adds the correct nucleotide.

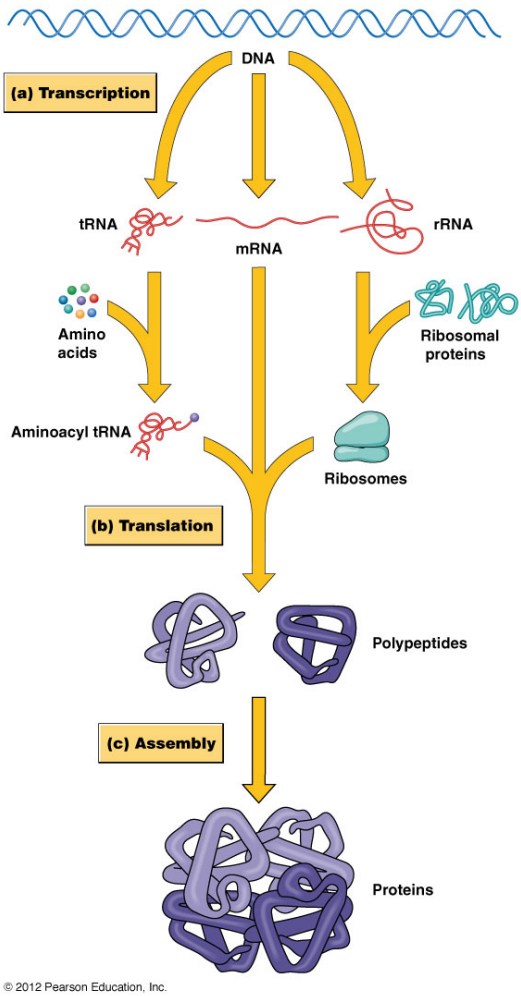
RNA STRUCTURE

3 types and what they do

mRNA- (Messenger) transcribes the genetic code from the DNA into form that can be read and used to make proteins, mRNA carries genetic information from the nucleus to the cytoplasm of a cell

rRNA- (Cytoplasm),where ribosomes are found. rRNA directs translation of mRNA into proteins

tRNA: (Cytoplasm) and is involved in protein synthesis. tRNA brings of transfers amino acids to the ribosome that correspond to each three nucleotide codon of **rRNA**.Amino acids then can be joined together and processed to make polypeptides and proteins.



Genetic engineering: Deliberate modification of characteristics of organism by manipulating its genetic material

PCR machine: Makes copies of DNA

Recombinant DNA: Recombinant DNA, general name for taking piece of one DNA, and combining it with another strand of DNA.

Mutation

- Changing of structure of a gene, resulting in variant form tha may be transmitted to subsequent generations, caused by alteration of single base units in DNA, or deletion, insertion, rearrangement of larger sections of genes or chromosomes
- Most part are random
- Can be helpful or hurtful
- Mutations called germ line mutations are the ones that matte evolution. They occur in the reproductive cells and end up being carried by gametes

Chromosomal Mutations.

- **Translocation:** Adding something that was not already ther into the chromosome
- **Deletion:** Missing 3 codons (a whole codon)
- **Inversion:** Switching the nucleotides around
- **Addition (duplication):** Extra copies of genes are generated on a chromosome

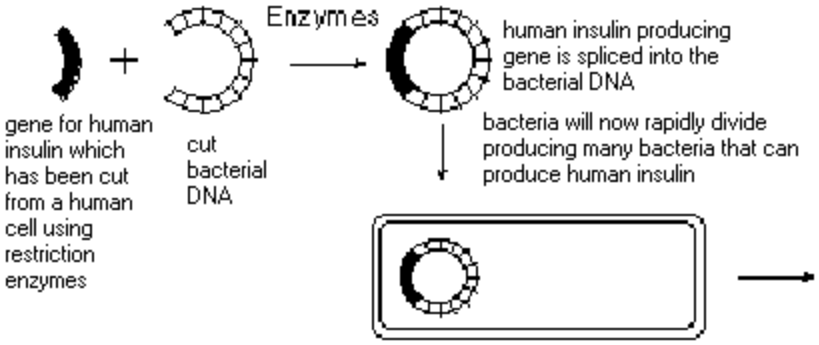
➢ **Frame Shift Mutation:** Nucleotides are added or deleted in a sequence hindering reading of codons (could cause cancer, cystic fibrosis, crohn's disease, cystic fibrosis)

➢ **Point Mutation**: Changing of a single base nucleotide with others.Occurs in DNA replication while free nucleotide bases combine wrong

- ➢ **Nondisjunction**: Failure of 1 or more pairs of homologous chromosomes or sister chromatids to separate normally during nuclear division, usually resulting in an abnormal distribution of chromosomes in the daughter nuclei.
- ➢ **Translocation**: Type of chromosomal abnormality in which a chromosome breaks and a portion of it reattaches to a different chromosome.

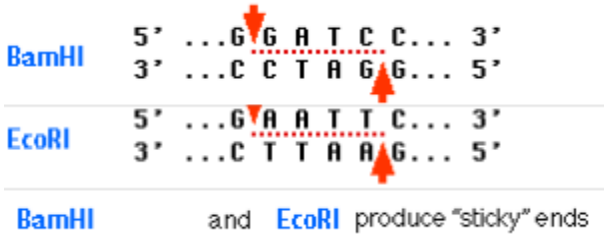
Down Syndrome Commonly called nondisjunction. An error in cell division where the person has 3 copies of the 21st chromosome instead of the normal 2.

Patau Syndrome Genetic mutation that causes the condition is an extra copy of the chromosome 13. Instead of 2 copies of chromosome 13 there is 3. The extra copy can translocate itself to another chromosome during the formation of reproductive cells in early development. Symptoms of trisomy 13 could be cleft lip or palate close set eyes, where the eyes fuse together, extra fingers or toes, severe intellectual disability, seizures, hole, split, or cleft in iris. There are exams taken during pregnancy to test for this. Heart disease are often signs of this, things like abnormal placement of heart in the chest. Ultrasounds may show rotation of the internal organs, MRI or CT scans can show problems in the formation of the brain. There are little to no treatments for living children with trisomy 13 because of the severity of their disabilities more than 80% die within the first year



Plasmid- genetic structure in a cell that can replicate independently of chromosomes. typically small circular DNA strand in the cytoplasm of a bacterium

Vector- a A vehicle (e.g. a plasmid) used to transfer the genetic material such as DNA sequences from the donor organism to the target cell of the recipient organism.



Restriction enzyme- enzymes that cut at exact locations

Ligation- the joining of two DNA strands or other molecules by a phosphate ester linkage

Gene Splicing- The process in which fragments of DNA from one or more different organisms are combined to form recombinant DNA.

Transformation transformation is the bacterial mechanism for the transfer of genetic material in which free DNA of one genotype is taken in through the cell surface of bacteria of another genotype and is incorporated into the recipient cell chromosome

Gel Electrophoresis- Gel electrophoresis is a technique used to separate mixtures like DNA and proteins. The separation is based on how positively or how negatively charged a molecule is and its size.