**DNA**

**Deoxyribonucleic acid**, more easily known as DNA, is a molecule composed of two chains that coil around each other to form a [double helix](https://en.wikipedia.org/wiki/Nucleic_acid_double_helix) carrying the [genetic](https://en.wikipedia.org/wiki/Genetics) instructions used in the growth, development, functioning and [reproduction](https://en.wikipedia.org/wiki/Reproduction) of all known living [organisms](https://en.wikipedia.org/wiki/Organism) and many [viruses](https://en.wikipedia.org/wiki/Virus). DNA and [ribonucleic acid](https://en.wikipedia.org/wiki/Ribonucleic_acid) (RNA) are [nucleic acids](https://en.wikipedia.org/wiki/Nucleic_acid); alongside [proteins](https://en.wikipedia.org/wiki/Protein), [lipids](https://en.wikipedia.org/wiki/Lipids) and complex carbohydrates ([polysaccharides](https://en.wikipedia.org/wiki/Polysaccharide)), nucleic acids are one of the four major types of [macromolecules](https://en.wikipedia.org/wiki/Macromolecule) that are essential for all known forms of [life](https://en.wikipedia.org/wiki/Life).

The two DNA strands are also known as [polynucleotides](https://en.wikipedia.org/wiki/Polynucleotide) as they are composed of simpler [monomeric](https://en.wikipedia.org/wiki/Monomer) units called [nucleotides](https://en.wikipedia.org/wiki/Nucleotide). Each nucleotide is composed of one of four [nitrogen-containing](https://en.wikipedia.org/wiki/Nitrogenous_base) [nucleobases](https://en.wikipedia.org/wiki/Nucleobase) ([cytosine](https://en.wikipedia.org/wiki/Cytosine) [C], [guanine](https://en.wikipedia.org/wiki/Guanine) [G], [adenine](https://en.wikipedia.org/wiki/Adenine) [A] or [thymine](https://en.wikipedia.org/wiki/Thymine) [T]), a [sugar](https://en.wikipedia.org/wiki/Monosaccharide) called [deoxyribose](https://en.wikipedia.org/wiki/Deoxyribose), and a [phosphate group](https://en.wikipedia.org/wiki/Organophosphate). The nucleotides are joined to one another in a chain by [covalent bonds](https://en.wikipedia.org/wiki/Covalent_bond) between the sugar of one nucleotide and the phosphate of the next, resulting in an alternating [sugar-phosphate backbone](https://en.wikipedia.org/wiki/Backbone_chain). The nitrogenous bases of the two separate polynucleotide strands are bound together, according to [base pairing](https://en.wikipedia.org/wiki/Base_pair) rules (A with T and C with G), with [hydrogen bonds](https://en.wikipedia.org/wiki/Hydrogen_bond) to make double-stranded DNA.

Both strands of double-stranded DNA store the same biological [information](https://en.wikipedia.org/wiki/Information). This information is replicated as and when the two strands separate. A large part of DNA (more than 98% for humans) is [non-coding](https://en.wikipedia.org/wiki/Non-coding_DNA), meaning that these sections do not serve as patterns for protein sequences.

The two strands of DNA run in opposite directions to each other and are thus [antiparallel](https://en.wikipedia.org/wiki/Antiparallel_(biochemistry)). Attached to each sugar is one of four types of nucleobases (informally, *bases*). It is the [sequence](https://en.wikipedia.org/wiki/Nucleic_acid_sequence) of these four nucleobases along the backbone that encodes genetic information. [RNA](https://en.wikipedia.org/wiki/RNA) strands are created using DNA strands as a template in a process called [transcription](https://en.wikipedia.org/wiki/Transcription_(genetics)). Under the [genetic code](https://en.wikipedia.org/wiki/Genetic_code), these RNA strands specify the sequence of [amino acids](https://en.wikipedia.org/wiki/Amino_acid) within proteins in a process called [translation](https://en.wikipedia.org/wiki/Translation_(genetics)).

Within eukaryotic cells, DNA is organized into long structures called [chromosomes](https://en.wikipedia.org/wiki/Chromosome). Before typical [cell division](https://en.wikipedia.org/wiki/Cell_division), these chromosomes are duplicated in the process of [DNA replication](https://en.wikipedia.org/wiki/DNA_replication), providing a complete set of chromosomes for each daughter cell. [Eukaryotic organisms](https://en.wikipedia.org/wiki/Eukaryote) ([animals](https://en.wikipedia.org/wiki/Animal), [plants](https://en.wikipedia.org/wiki/Plant), [fungi](https://en.wikipedia.org/wiki/Fungus) and [protists](https://en.wikipedia.org/wiki/Protist)) store most of their DNA inside the [cell nucleus](https://en.wikipedia.org/wiki/Cell_nucleus) and some in [organelles](https://en.wikipedia.org/wiki/Organelle), such as [mitochondria](https://en.wikipedia.org/wiki/Mitochondrion) or [chloroplasts](https://en.wikipedia.org/wiki/Chloroplast).[[4]](https://en.wikipedia.org/wiki/DNA#cite_note-4) In contrast, [prokaryotes](https://en.wikipedia.org/wiki/Prokaryote) ([bacteria](https://en.wikipedia.org/wiki/Bacteria) and [archaea](https://en.wikipedia.org/wiki/Archaea)) store their DNA only in the [cytoplasm](https://en.wikipedia.org/wiki/Cytoplasm). Within eukaryotic chromosomes, [chromatin](https://en.wikipedia.org/wiki/Chromatin) proteins, such as [histones](https://en.wikipedia.org/wiki/Histone), compact and organize DNA. These compact structures guide the interactions between DNA and other proteins, helping control which parts of the DNA are transcribed.

DNA was first isolated by [Friedrich Miescher](https://en.wikipedia.org/wiki/Friedrich_Miescher) in 1869. Its molecular structure was first identified by [James Watson](https://en.wikipedia.org/wiki/James_Watson) and [Francis Crick](https://en.wikipedia.org/wiki/Francis_Crick) at the [Cavendish Laboratory](https://en.wikipedia.org/wiki/Cavendish_Laboratory) within the [University of Cambridge](https://en.wikipedia.org/wiki/University_of_Cambridge) in 1953, whose model-building efforts were guided by [X-ray diffraction](https://en.wikipedia.org/wiki/X-ray_diffraction) data acquired by [Raymond Gosling](https://en.wikipedia.org/wiki/Raymond_Gosling), who was a post-graduate student of [Rosalind Franklin](https://en.wikipedia.org/wiki/Rosalind_Franklin). DNA is used by researchers as a molecular tool to explore physical laws and theories, such as the [ergodic theorem](https://en.wikipedia.org/wiki/Ergodic_theorem) and the theory of [elasticity](https://en.wikipedia.org/wiki/Elasticity_(physics)). The unique material properties of DNA have made it an attractive molecule for material scientists and engineers interested in micro- and nano-fabrication. Among notable advances in this field are [DNA origami](https://en.wikipedia.org/wiki/DNA_origami) and DNA-based hybrid materials.

DNA is a long [polymer](https://en.wikipedia.org/wiki/Polymer) made from repeating units called [nucleotides](https://en.wikipedia.org/wiki/Nucleotide). The structure of DNA is dynamic along its length, being capable of coiling into tight loops and other shapes. In all species it is composed of two helical chains, bound to each other by [hydrogen bonds](https://en.wikipedia.org/wiki/Hydrogen_bonds). Although each individual nucleotide repeating unit is very small, DNA polymers can be very large molecules containing hundreds of millions of nucleotides. For instance, the DNA in the largest human [chromosome](https://en.wikipedia.org/wiki/Chromosome), chromosome [number 1](https://en.wikipedia.org/wiki/Chromosome_1_(human)), consists of approximately 220 million [base pairs](https://en.wikipedia.org/wiki/Base_pair) and would be 85 mm long if straightened.

In living organisms, DNA does not usually exist as a single strand, but instead as a pair of strands that are held tightly together. These two long strands entwine like vines, in the shape of a [double helix](https://en.wikipedia.org/wiki/Double_helix). The nucleotide contains both a segment of the backbone of the molecule (which holds the chain together) and a nucleobase (which interacts with the other DNA strand in the helix). A nucleobase linked to a sugar is called a [nucleoside](https://en.wikipedia.org/wiki/Nucleoside) and a base linked to a sugar and one or more phosphate groups is called a [nucleotide](https://en.wikipedia.org/wiki/Nucleotide). A polymer comprising multiple linked nucleotides (as in DNA) is called a [polynucleotide](https://en.wikipedia.org/wiki/Polynucleotide).

The backbone of the DNA strand is made from alternating [phosphate](https://en.wikipedia.org/wiki/Phosphate) and [sugar](https://en.wikipedia.org/wiki/Carbohydrate) residues. One major difference between DNA and [RNA](https://en.wikipedia.org/wiki/RNA) is the sugar, with the 2-deoxyribose in DNA being replaced by the alternative pentose sugar [ribose](https://en.wikipedia.org/wiki/Ribose) in RNA.

The DNA double helix is stabilized primarily by two forces: [hydrogen bonds](https://en.wikipedia.org/wiki/Hydrogen_bond) between nucleotides and [base-stacking](https://en.wikipedia.org/wiki/Stacking_(chemistry)) interactions among [aromatic](https://en.wikipedia.org/wiki/Aromatic) nucleobases. In the aqueous environment of the cell, the conjugated [π bonds](https://en.wikipedia.org/wiki/Pi_bond) of nucleotide bases align perpendicular to the axis of the DNA molecule, minimizing their interaction with the [solvation shell](https://en.wikipedia.org/wiki/Solvation_shell). The four bases found in DNA are [adenine](https://en.wikipedia.org/wiki/Adenine) (A), [cytosine](https://en.wikipedia.org/wiki/Cytosine) (C), [guanine](https://en.wikipedia.org/wiki/Guanine) (G) and [thymine](https://en.wikipedia.org/wiki/Thymine) (T). These four bases are attached to the sugar-phosphate to form the complete nucleotide, as shown for [adenosine monophosphate](https://en.wikipedia.org/wiki/Adenosine_monophosphate). Adenine pairs with thymine and guanine pairs with cytosine, forming A-T and G-C [base pairs](https://en.wikipedia.org/wiki/Base_pair).

**Assignment**

* Standard reading assignment:
  + Pick 5 words and define
  + Make a question for each word
    - No definition or yes/no questions
  + Answer each question
    - How does your DNA make you unique? Find 3 traits that **only you** have in the classroom.
    - Why can you not mix your DNA with a different species?