What is DNA?

DNA is self-replicating material that's in every living organism. In simplest terms, it is a carrier of all genetic information. It contains the instructions needed for organisms to develop, grow, survive, and reproduce. It's one long molecule that contains our genetic "code," or recipe. This recipe is the starting point for our development, but DNA's interaction with outside influences such as our lifestyle, environment, and nutrition ultimately form the human being.

While most DNA is found in the nucleus of a cell, a small amount can also be found in the mitochondria, which generates energy so cells can function properly. Perhaps the most fascinating part of the process is the fact that nearly every cell in your body has the same DNA.

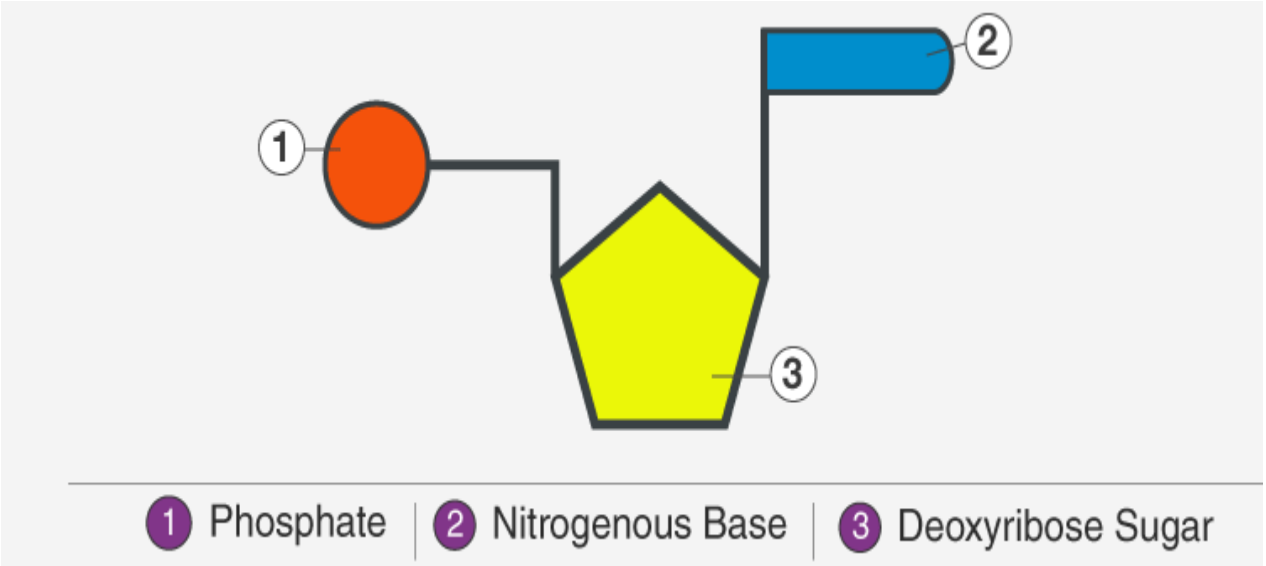
DNA Structure

The DNA structure can be thought of like a twisted ladder. This structure is described as a double-helix, as illustrated in the figure above. It is a nucleic acid, and all nucleic acids are made up of nucleotides. The DNA molecule is composed of units called nucleotides, and each nucleotide is composed of three different components, such as sugar, phosphate groups and nitrogen bases.

The basic building blocks of DNA are nucleotides, which are composed of a sugar group, a phosphate group, and a nitrogen base. The sugar and phosphate groups link the nucleotides together to form each strand of DNA. Adenine (A), Thymine (T), Guanine (G) and Cytosine (C) are four types of nitrogen bases.

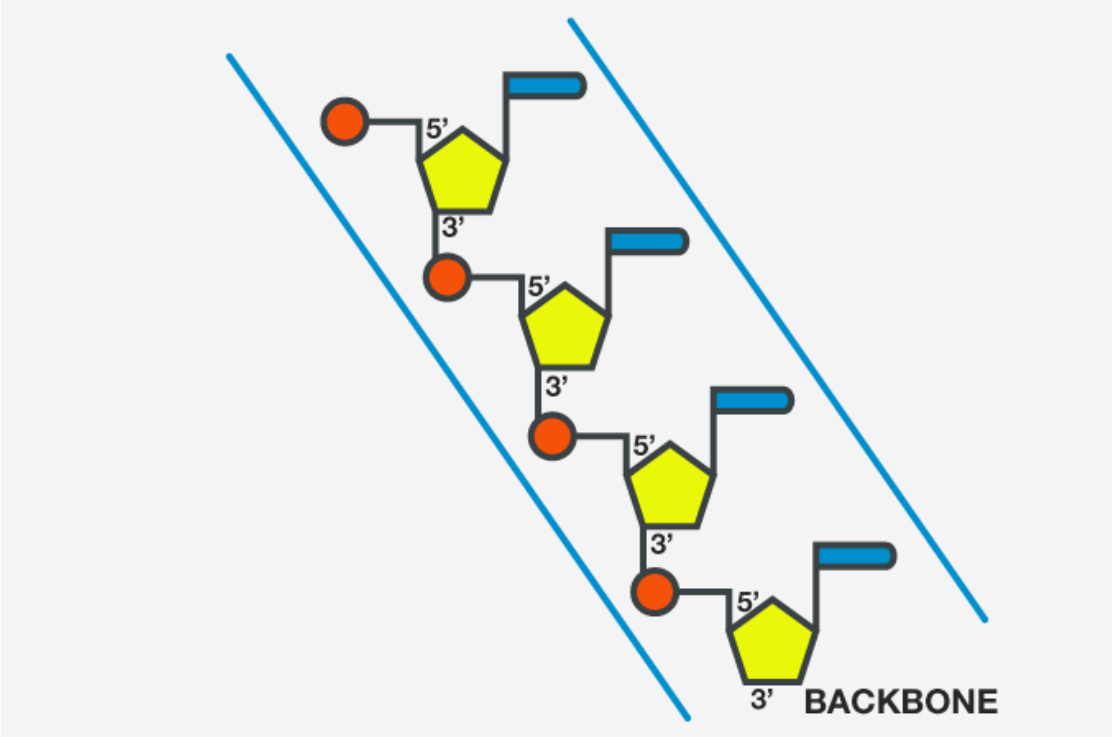
These 4 Nitrogenous bases pair together in the following way: A with T, and C with G. These base pairs are essential for the DNA's double helix structure, which resembles a twisted ladder.

The order of the nitrogenous bases determines the genetic code or the DNA's instructions.



Components of DNA Structure

Among the three components of DNA structure, sugar is the one which forms the backbone of the DNA molecule. It is also called deoxyribose. The nitrogenous bases of the opposite strands form hydrogen bonds, forming a ladder-like structure.

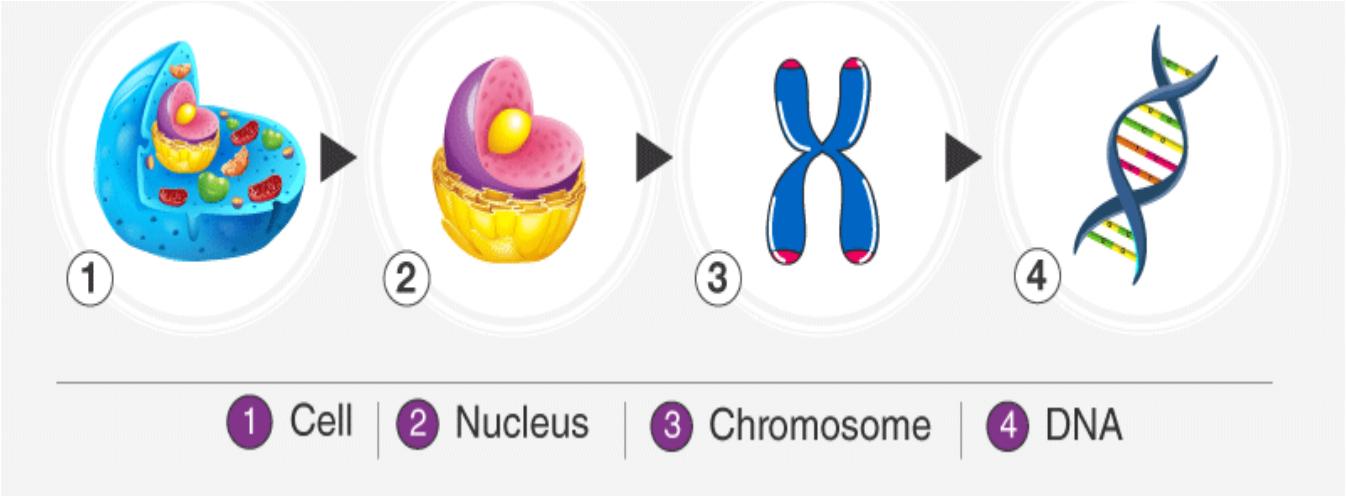


DNA Structure Backbone

The DNA molecule consists of 4 nitrogen bases, namely adenine (A), thymine (T), cytosine (C) and Guanine (G) which ultimately forms the structure of a nucleotide. The A and G are purines and the C and T are pyrimidines.

The two strands of DNA run in opposite directions. These strands are held together by the hydrogen bond that is present between the two complementary bases. The strands are helically twisted, where each strand forms a right-handed coil and ten nucleotides make up a single turn.

The pitch of each helix is 3.4 nm. Hence, the distance between two consecutive base pairs (i.e., hydrogen-bonded bases of the opposite strands) is 0.34 nm.



The DNA coils up, forming chromosomes, and each chromosome has a single molecule of DNA in it. Overall, human beings have around twenty-three pairs of chromosomes in the nucleus of cells. DNA also plays an essential role in the process of cell division.

DNA discovery

DNA was first observed by a German biochemist named Frederich Miescher in 1869. But for many years, researchers did not realize the importance of this molecule. It was not until 1953 that James Watson, Francis Crick, Maurice Wilkins and Rosalind Franklin figured out the structure of DNA — a double helix — which they realized could carry biological information.

Watson, Crick and Wilkins were awarded the Nobel Prize in

Medicine in 1962 "for their discoveries concerning the molecular structure of nucleic acids and its significance for information transfer in living material." Franklin was not included in the award, although her work was integral to the research. [Related: Unraveling the Human Genome: 6 Molecular Milestones]

When Was DNA Discovered?

What we know about DNA today can be largely credited to James Watson and Francis Crick, who discovered the structure of DNA in 1953. Despite there being many important and contributing discoveries both before and after their work, this is the year they discovered DNA's double helix, or spiraling, intertwined structure, which is fundamental to our current understanding of DNA as a whole

Who Discovered DNA?

The full answer to the question who discovered DNA is complex, because in truth, many people have contributed to what we know about it. DNA was first discovered by Friedrich Miescher, but researchers and scientists continue to expound on his work to this day, as we are still learning more about its mysteries. As it turned out, Miescher's discovery was just the beginning.

Credit for who first identified DNA is often mistakenly given to James Watson and Francis Crick, who actually just furthered Miescher's discovery with their own groundbreaking research nearly 100 years later. Watson and Crick contributed largely to our understanding of DNA in terms of genetic inheritance, but much like Miescher, long before their work, others also made great advancements in and contributions to the field.

1866 – Before the many significant discoveries and findings, Gregor Mendel, who is known as the "Father of Genetics," was actually the first to suggest that characteristics are passed down from generation to generation. Mendel coined the terms we all know today as recessive and dominant.

1869 – Friedrich Miescher identified the "nuclein" by isolating a molecule from a cell nucleus that would later become known as DNA.

1881 – Nobel Prize winner and German biochemist Albrecht Kossel, who is credited with naming DNA, identified nuclein as a nucleic acid. He also isolated those five nitrogen bases that are now considered to be the basic building blocks of DNA and RNA: adenine (A), cytosine (C), guanine (G), and thymine (T) (which is replaced by uracil (U) in RNA).

1882 – Shortly after Kossel's findings, Walther Flemming devoted research and time to cytology, which is the study of chromosomes. He discovered mitosis in 1882 when he was the first biologist to execute a wholly systematic study of the division of chromosomes. His observations that chromosomes double is significant to the later-discovered theory of inheritance.

Early 1900s – Theodor Boveri and Walter Sutton were independently working on what's now known as the Boveri-Sutton chromosome theory, or the chromosomal theory of inheritance. Their findings are fundamental in our understanding of how chromosomes carry genetic material and pass it down from one generation to the next.

1902 – Mendel's theories were finally associated with a human disease by Sir Archibald Edward Garrod, who published the first

findings from a study on recessive inheritance in human beings in 1902. Garrod opened the door for our understanding of genetic disorders resulting from errors in chemical pathways in the body.

1944 – Oswald Avery first outlined DNA as the transforming principle, which essentially means that it's DNA, not proteins, that transform cell properties .

1944 – 1950 – Erwin Chargaff discovered that DNA is responsible for heredity and that it varies between species. His discoveries, known as Chargaff's Rules, proved that guanine and cytosine units, as well as adenine and thymine units, were the same in double-stranded DNA, and he also discovered that DNA varies among species.

Late 1940s – Barbara McClintock discovered the mobility of genes, ultimately challenging virtually everything that was once thought to be. Her discovery of the "jumping gene," or the idea that genes can move on a chromosome, earned her the Nobel Prize in Physiology.

1951 – Roslind Franklin's work in X-ray crystallography began when she started taking X-ray diffraction photographs of DNA. Her images showed the helical form, which was confirmed by Watson and Crick nearly two years later. Her findings were only acknowledged posthumously.

1953 – Watson and Crick published on DNA's double helix structure that twists to form the ladder-like structure we think of when we picture DNA.

DNA sequencing

DNA sequencing is technology that allows researchers to determine

the order of bases in a DNA sequence. The technology can be used to determine the order of bases in genes, chromosomes, or an entire genome. In 2000, researchers completed the first full sequence of the human genome, according to a report by the National Human Genome Research Institute

The Future of DNA

The future of DNA has great potential. As researchers and scientists continue to advance what we know about the complexities of DNA and the insights it codes for, we can imagine a world with less and better-managed disease, longer life spans, and a personalized view of medicine that's specifically applicable to individuals rather than the population as a whole.

DNA insights are already enabling the diagnosis and treatment of genetic diseases. Science is also hopeful that medicine will advance to be able to leverage the power of our own cells to fight disease. For example, gene therapy is designed to introduce genetic material into cells to compensate for abnormal genes or to make a therapeutically beneficial protein.

Researchers also continue to use DNA sequencing technology to learn more about everything from combating infectious disease outbreaks to improving nutritional security.

Ultimately, DNA research will accelerate breaking the mold of the one-size-fits-all approach to medicine. Every new discovery in our understanding of DNA lends to further advancement in the idea of precision medicine, a relatively new way doctors are approaching healthcare through the use of genetic and molecular information to guide their approach to medicine. With precision or personalized

medicine, interventions take into consideration the unique biology of the patient and are tailored individually to each patient, rather than being based on the predicted response for all patients. Using genetics and a holistic view of individual genetics, lifestyle, and environment on a case-by-case basis, doctors are better able to not only predict accurate prevention strategies, but also suggest more effective treatment options.

We've come leaps and bounds from where we were in terms of our understanding of DNA 150 years ago. But still, there is much to learn. And with the potential that a deeper understanding of DNA will improve human health and quality of life across our world, no doubt, the research will continue. A full understanding of DNA of and between all living things could one day contribute to solving problems like world hunger, disease prevention, and fighting climate change. The potential truly is unlimited, and to say the least, extremely exciting.

How To Do More With Your DNA

Until recently, individuals were sources of samples in the traditional research model. Today, the gap between research and individual is closing and the community is coming together to contribute health data to support research at scale, advance science, and accelerate medical discoveries at LunaDNATM.

If you'd like to help researchers better understand you, your family, and your family health history, take the LunaDNA family health history survey or share your DNA data file. The more people who come together to contribute health data for the greater good, the quicker and more efficient research will scale, and improve the quality of life for us all