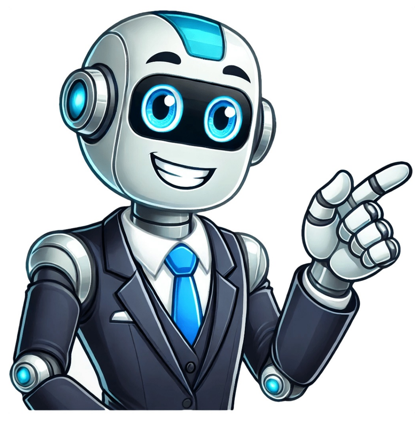

Structure of dna labeled

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Explore our latest gallery of Editors’ Picks.Browse Editors' FavoritesExperience AI-Powered Creativity Deoxyribonucleic acid (DNA) is an important information-carrying moleculeThe function of DNA is to hold or store genetic informationDNA is the molecule that contains the instructions for the growth and development of all organismsThe nucleic acid DNA is a polynucleotide – it is made up of many nucleotides bonded together in a long chainA DNA nucleotideDNA molecules are made up of two polynucleotide strands lying side by side, running in opposite directions – the strands are said to be antiparallelEach DNA polynucleotide strand contains alternating deoxyribose sugars and phosphate groups bonded to form the sugar-phosphate backbone. These bonds are covalent bonds known as phosphodiester bondsThe phosphodiester bonds link the 5-carbon of one deoxyribose sugar molecule to the phosphate group from the same nucleotide, which is itself linked by another phosphodiester bond to the 3-carbon of the deoxyribose sugar molecule of the next nucleotide in the strandEach DNA polynucleotide strand is said to have a 3’ end and a 5’ end (these numbers relate to which carbon on the pentose sugar could be bonded with another nucleotide)As the strands run in opposite directions (they are antiparallel), one is known as the 5’ to 3’ strand, and the other is known as the 3’ to 5’ strandThe nitrogenous bases of each nucleotide project out from the backbone towards the interior of the double-stranded DNA moleculeA single DNA polynucleotide strand showing the positioning of the ester bondsThe two antiparallel DNA polynucleotide strands that make up the DNA molecule are held together by hydrogen bonds between the nitrogenous basesThese hydrogen bonds always occur between the same pairs of bases:Adenine (A) always pairs with thymine (T) – two hydrogen bonds are formed between these basesGuanine (G) always pairs with cytosine (C) – three hydrogen bonds are formed between these basesThis is known as complementary base pairingThese pairs are known as DNA base pairsA section of DNA – two antiparallel DNA polynucleotide strands held together by hydrogen bondsDNA is not two-dimensional as seen in the diagram aboveDNA is described as a double helixThis refers to the three-dimensional shape that DNA molecules formDNA molecules form a three-dimensional structure known as a DNA double helixBe able to identify and label the components of a DNA molecule:Sugar-phosphate backboneNucleotidesComplementary base pairs (A=T, C≡G)Phosphodiester bonds (between nucleotides)Hydrogen bonds (between bases)You may be asked to calculate base numbers using base pairing rules if given the quantity of one base.Did this page help you?Expertise: Head of STEMLucy has been a passionate Maths teacher for over 12 years, teaching maths across the UK and abroad helping to engage, interest and develop confidence in the subject at all levels.Working as a Head of Department and then Director of Maths, Lucy has advised schools and academy trusts in both Scotland and the East Midlands, where her role was to support and coach teachers to improve Maths teaching for all. The diagram of DNA structure shows a double helical arrangement and complementary base pairing. The DNA full form is Deoxyribonucleic acid. The DNA functions to store and transmit genetic information from one generation to another. The diagram of DNA class 12 provides insight into the processes like replication, transcription, and translation essential for cellular function and inheritance. The labelled diagram of DNA structure is given below: Diagram of DNA What is DNA?DNA, or deoxyribonucleic acid, is a double-stranded molecule that serves as the genetic blueprint for all living organisms. Its structure, a double helix, is fundamental to understanding how genetic information is stored and transmitted. The DNA diagram show double helix that consists of two long strands of nucleotides arranged in a spiral staircase-like configuration. Each nucleotide is composed of three components: a phosphate group, a sugar molecule (deoxyribose), and a nitrogenous base. The sugar-phosphate backbone forms the sides of the DNA ladder, providing stability and protection to the nitrogenous bases inside. Also Read: What are the Three Main Parts of a Nucleotide? DNA StructureThe diagram of DNA structure helps in understanding its complex organisation. The DNA's structure is arranged in its complementary base pairing. The four nitrogenous bases found in DNA are adenine (A), thymine (T), cytosine (C), and guanine (G). Adenine pairs specifically with thymine, forming two hydrogen bonds.While cytosine pairs with guanine, forming three hydrogen bonds. Polynucleotide ChainThis complementary base pairing ensures that the two strands of DNA are held together by hydrogen bonds. This specificity of base pairing is important for replication of DNA during cell division. The structure of DNA has ability to store and transmit genetic information. The sequence of nucleotides along the DNA strands encodes the instructions for building proteins, which are essential for the structure and function of cells. Genes are specific sequences of nucleotides that contain information for specific traits or characteristics. Through processes like transcription and translation, the genetic information encoded in DNA is used to synthesize proteins, regulate gene expression, and carry out various cellular functions. Also Read: Search for Genetic Material Characteristics of DNA Some of the characteristics of DNA as studied from DNA diagram is given below: Double-stranded helical structure.Composed by nucleotides divided into Purine and Pyrimidine.Sugar-phosphate backbone provide extra stability to the DNA.Four nitrogenous bases: adenine, thymine, cytosine, guanine.Base pairing: A-T with 2 hydrogen bond, C-G with 3 hydrogen bond.DNA carries genetic informationIt is essential for protein synthesisDNA Replicates during cell divisionDetermines traits and heredityHighly stable and resilient moleculeConclusion: Diagram of DNA Structure The diagram of DNA structure depicts a double helix structure, with nucleotides forming the sugar-phosphate backbone and nitrogenous bases pairing via hydrogen bonds. This arrangement ensures accurate genetic information storage and transmission, fundamental to the functioning and evolution of all living organisms. Also Read: Biologists in the 1940s had difficulty in accepting DNA as the genetic material because of the apparent simplicity of its chemistry. DNA was known to be a long polymer composed of only four types of subunits, which resemble one another chemically. Early in the 1950s, DNA was first examined by x-ray diffraction analysis, a technique for determining the three-dimensional atomic structure of a molecule (discussed in Chapter 8). The early x-ray diffraction results indicated that DNA was composed of two strands of the polymer wound into a helix. The observation that DNA was double-stranded was of crucial significance and provided one of the major clues that led to the Watson-Crick structure of DNA. Only when this model was proposed did DNA's potential for replication and information encoding become apparent. In this section we examine the structure of the DNA molecule and explain in general terms how it is able to store hereditary information.A DNA molecule consists of two long polynucleotide chains composed of four types of nucleotide subunits. Each of these chains is known as a DNA chain, or a DNA strand. Hydrogen bonds between the base portions of the nucleotides hold the two chains together (Figure 4-3). As we saw in Chapter 2 (Panel 2-6, pp. 120-121), nucleotides are composed of a five-carbon sugar to which are attached one or more phosphate groups and a nitrogen-containing base. In the case of the nucleotides in DNA, the sugar is deoxyribose attached to a single phosphate group (hence the name deoxyribonucleic acid), and the base may be either adenine (A), cytosine (C), guanine (G), or thymine (T). The nucleotides are covalently linked together in a chain through the sugars and phosphates, which thus form a “backbone” of alternating sugar-phosphate-sugar-phosphate (see Figure 4-3). Because only the base differs in each of the four types of subunits, each polynucleotide chain in DNA is analogous to a necklace (the backbone) strung with four types of beads (the four bases A, C, G, and T). These same symbols (A, C, G, and T) are also commonly used to denote the four different nucleotides—that is, the bases with their attached sugar and phosphate groups. The way in which the nucleotide subunits are lined together gives a DNA strand a chemical polarity. If we think of each sugar as a block with a protruding knob (the 5′ phosphate) on one side and a hole (the 3′ hydroxyl) on the other (see Figure 4-3), each completed chain, formed by interlocking knobs with holes, will have all of its subunits lined up in the same orientation. Moreover, the two ends of the chain will be easily distinguishable, as one has a hole (the 3′ hydroxyl) and the other a knob (the 5′ phosphate) at its terminus. This polarity in a DNA chain is indicated by referring to one end as the 3′ end and the other as the 5′ end.The three-dimensional structure of DNA—the double helix—arises from the chemical and structural features of its two polynucleotide chains. Because these two chains are held together by hydrogen bonding between the bases on the different strands, all the bases are on the inside of the double helix, and the sugar-phosphate backbones are on the outside (see Figure 4-3). In each case, a bulkier two-ring base (a purine; see Panel 2-6, pp. 120–121) is paired with a single-ring base (a pyrimidine); A always pairs with T, and G with C (Figure 4-4). This complementary base-pairing enables the base pairs to be packed in the energetically most favorable arrangement in the interior of the double helix. In this arrangement, each base pair is of similar width, thus holding the sugar-phosphate backbones an equal distance apart along the DNA molecule. To maximize the efficiency of base-pair packing, the two sugar-phosphate backbones wind around each other to form a double helix, with one complete turn every ten base pairs (Figure 4-5). The members of each base pair can fit together within the double helix only if the two strands of the helix are antiparallel—that is, only if the polarity of one strand is oriented opposite to that of the other strand (see Figures 4-3 and 4-4). A consequence of these base-pairing requirements is that each strand of a DNA molecule contains a sequence of nucleotides that is exactly complementary to the nucleotide sequence of its partner strand.Genes carry biological information that must be copied accurately for transmission to the next generation each time a cell divides to form two daughter cells. Two central biological questions arise from these requirements: how can the information for specifying an organism be carried in chemical form, and how is it accurately copied? The discovery of the structure of the DNA double helix was a landmark in twentieth-century biology because it immediately suggested answers to both questions, thereby resolving at the molecular level the problem of heredity. We discuss briefly the answers to these questions in this section, and we shall examine them in more detail in subsequent chapters.DNA encodes information through the order, or sequence, of the nucleotides along each strand. Each base—A, C, T, or G—can be considered as a letter in a four-letter alphabet that spells out biological messages in the chemical structure of the DNA. As we saw in Chapter 1, organisms differ from one another because their respective DNA molecules have different nucleotide sequences and, consequently, carry different biological messages. But how is the nucleotide alphabet used to make messages, and what do they spell out?As discussed above, it was known well before the structure of DNA was determined that genes contain the instructions for producing proteins. The DNA messages must therefore somehow encode proteins (Figure 4-6). This relationship immediately makes the problem easier to understand, because of the chemical character of proteins. As discussed in Chapter 3, the properties of a protein, which are responsible for its biological function, are determined by its three-dimensional structure, and its structure is determined in turn by the linear sequence of the amino acids of which it is composed. The linear sequence of nucleotides in a gene must therefore somehow spell out the linear sequence of amino acids in a protein. The exact correspondence between the four-letter nucleotide alphabet of DNA and the twenty-letter amino acid alphabet of proteins—the genetic code—is not obvious from the DNA structure, and it took over a decade after the discovery of the double helix before it was worked out. In Chapter 6 we describe this code in detail in the course of elaborating the process, known as gene expression, through which a cell translates the nucleotide sequence of a gene into the amino acid sequence of a protein. The complete set of information in an organism's DNA is called its genome, and it carries the information for all the proteins the organism will ever synthesize. (The term genome is also used to describe the DNA that carries this information.) The amount of information contained in genomes is staggering: for example, a typical human cell contains 2 meters of DNA. Written out in the four-letter nucleotide alphabet, the nucleotide sequence of a very small human gene occupies a quarter of a page of text (Figure 4-7), while the complete sequence of nucleotides in the human genome would fill more than a thousand books the size of this one. In addition to other critical information, it carries the instructions for about 30,000 distinct proteins. At each cell division, the cell must copy its genome to pass it to both daughter cells. The discovery of the structure of DNA also revealed the principle that makes this copying possible: because each strand of DNA contains a sequence of nucleotides that is exactly complementary to the nucleotide sequence of its partner strand, each strand can act as a template, or mold, for the synthesis of a new complementary strand. In other words, if we designate the two DNA strands as S and S′, strand S can serve as a template for making a new strand S′, while strand S′ can serve as a template for making a new strand S (Figure 4-8). Thus, the genetic information in DNA can be accurately copied by the beautifully simple process in which strand S separates from strand S′, and each separated strand then serves as a template for the production of a new complementary partner strand that is identical to its former partner. The ability of each strand of a DNA molecule to act as a template for producing a complementary strand enables a cell to copy, or replicate, its genes before passing them on to its descendants. In the next chapter we describe the elegant machinery the cell uses to perform this enormous task.Nearly all the DNA in a eucaryotic cell is sequestered in a nucleus, which occupies about 10% of the total cell volume. This compartment is delimited by a nuclear envelope formed by two concentric lipid bilayer membranes that are punctured at intervals by large nuclear pores, which transport molecules between the nucleus and the cytosol. The nuclear envelope is directly connected to the extensive membranes of the endoplasmic reticulum. It is mechanically supported by two networks of intermediate filaments: one, called the nuclear lamina, forms a thin sheetlike meshwork inside the nucleus, just beneath the inner nuclear membrane; the other surrounds the outer nuclear membrane and is less regularly organized (Figure 4-9). The nuclear envelope allows the many proteins that act on DNA to be concentrated where they are needed in the cell, and, as we see in subsequent chapters, it also keeps nuclear and cytosolic enzymes separate, a feature that is crucial for the proper functioning of eucaryotic cells. Compartmentalization, of which the nucleus is an example, is an important principle of biology; it serves to establish an environment in which biochemical reactions are facilitated by the high concentration of both substrates and the enzymes that act on them.Genetic information is carried in the linear sequence of nucleotides in DNA. Each molecule of DNA is a double helix formed from two complementary strands of nucleotides held together by hydrogen bonds between G-C and A-T base pairs. Duplication of the genetic information occurs by the use of one DNA strand as a template for formation of a complementary strand. The genetic information stored in an organism's DNA contains the instructions for all the proteins the organism will ever synthesize. In eucaryotes, DNA is contained in the cell nucleus. This is a question and answer forum for students, teachers and general visitors for exchanging articles, answers and notes. Answer Now and help others. Answer Now Here's how it works: Anybody can ask a question Anybody can answer The best answers are voted up and rise to the top DNA (deoxyribonucleic acid) molecules are nucleic acids, which are the information-carrying molecules of the cell. DNA molecules are polymers and are made up of many smaller molecules, called nucleotides. Each nucleotide contains a phosphate group, a sugar molecule, and a nitrogenous base. DNA molecules consist of two DNA strands, which are twisted around one another to form a spiral shape known as the double helix. The double helix structure of DNA was first discovered in 1953 by James Watson, Francis Crick, and Rosalind Franklin. DNA molecules are found in the nucleus and store the genetic code; that is, all the information required for an organism to function. What is the structure of DNA? What is the Structure of DNA? DNA molecules are polymers, which means they are large molecules made up of many smaller molecules. The small molecules that make up DNA are called nucleotides. Each nucleotide contains a phosphate group, a sugar molecule (called deoxyribose), and a nitrogenous base. A nucleotide There are four types of nitrogenous bases found in DNA molecules. These are: Adenine Guanine Cytosine Thymine The order of the nucleotides in a DNA molecule is known as the DNA sequence or genetic code. The genetic code determines which instructions are encoded in the DNA molecule; for example, how to make a certain type of protein. Nucleotides are strongly linked together by phosphodiester bonds, which form between the 3’ carbon atom of one sugar molecule and the 5’ carbon atom of another. A phosphodiester bond The nucleotides that make up DNA are joined together like a long string of beads, called a DNA strand. Each DNA molecule contains two DNA strands, which are twisted around one another to make a spiral-like shape called the double helix. Together, the phosphate groups and sugars form the sugar-phosphate backbone, which makes up the outside of the DNA molecule. The nitrogenous bases point inwards, like the rungs of a ladder, and are joined together in base pairs. The base pairs of DNA are: Adenine-thymine Guanine-cytosine Base pairs in DNA The two strands of the double helix run in opposite directions to one another, meaning that the 5’ end of one strand faces the 3’ end of the other. This is called the antiparallel orientation, and it is essential for successful DNA replication. Who Discovered the Structure of DNA? The double helix structure of DNA was first discovered in 1953 by James Watson (an American Biologist), Francis Crick (an English Physicist), and Rosalind Franklin (an English Chemist). Though only Watson and Crick were credited with the discovery of the double helix, they are believed to have made their discovery with the help of Franklin’s data. Franklin was an expert in an imaging technique called X-ray crystallography, which she used to produce the first ever image of the helical shape of DNA. Watson and Crick were awarded the Nobel Prize for their work in 1962. Despite her contribution to the discovery, Franklin was not awarded the prize, having died of cancer four years earlier. DNA vs. RNA: What’s the Difference? DNA and RNA are very similar molecules. Both are types of nucleic acid, both contain genetic information, and both can be found in the nuclei of cells. The structure of RNA nucleotides are also similar to those of DNA; both contain a phosphate group, a sugar molecule, and a nitrogenous base. However, there are some key differences between DNA and RNA molecules. Whereas DNA contains deoxyribose, RNA contains a different type of sugar molecule, called ribose. They also contain slightly different nitrogenous bases. Though both DNA and RNA contain adenine, guanine, and cytosine, RNA contains uracil instead of thymine. And, unlike DNA, RNA molecules are usually single-stranded. DNA vs. RNA DNA and RNA molecules also have slightly different functions. DNA molecules store the genetic information of a cell, which is used to carry out the functions of the cell. RNA is used to transfer this genetic information from the nucleus to the ribosomes (the cell organelles used to make proteins). What is DNA Replication? DNA replication is a process in which two identical DNA replicas are produced from a single DNA molecule. It is an essential part of cell division, which is necessary for the growth and repair of damaged tissues. DNA replication ensures that each new daughter cell receives a complete copy of the organism’s genetic information. This allows each new cell to function correctly, and the organism to thrive. DNA stands for Deoxyribonucleic acid, a macromolecule that carries genetic information in all living organisms, from the tiniest microorganisms to the most complex multicellular humans. DNA is a fundamental molecule that holds life’s blueprint. Within a eukaryotic cell (plant and animal), they are found inside the nucleus, distributed among its chromosomes. Chromosomes consist of thousands of short DNA segments called genes. In contrast, DNA is located within a central dense area called the nucleoid in a prokaryotic cell like bacteria. Since DNA reside inside the cell, it is too small to be seen with the naked eye. They are visible only under an electron microscope. Some organisms have ribonucleic acid (RNA) instead of DNA as their genetic material. In the early 1950s, Rosalind Franklin and Maurice Wilkins used X-ray crystallography to discover the DNA structure. Using Franklin’s data and their studies, James Watson and Francis Crick established the double-helical structure of DNA in 1953. According to Watson and Crick, the basic building block of DNA is the nucleotide, which consists of three parts: a sugar molecule called deoxyribose, a phosphate group, and a nitrogenous base. Deoxyribose: It is a five-carbon sugar molecule that forms the backbone of the DNA strands. The deoxyribose sugar molecules are connected through a phosphodiester bond, creating a sugar-phosphate backbone.Phosphate Group: It is attached to the 5’ carbon of the deoxyribose sugar. The phosphate group is responsible for linking adjacent nucleotides together through phosphodiester bonds. The phosphate group gives the DNA a negative charge.Nitrogenous Bases: In a cell, there are four types of nitrogenous bases: adenine (A), thymine (T), cytosine (C), and guanine (G). These bases project from the sugar-phosphate backbone into the interior of the helix and are involved in complementary base pairing. DNA Structure The two DNA strands (polymers) wound around each other in a right-handed double helix that looks like a twisted ladder or a spiral-shaped staircase. Each helix turn or complete double helix rotation measures approximately 34 Angstroms (Å) in length. The 5’ carbon of one nucleotide is connected to the 3’ carbon of another nucleotide by phosphodiester bonds. There is a covalent bonding between the oxygen of the 3’ carbon of the first nucleotide and the phosphorous in the phosphate group of the 5’ carbon of the second nucleotide. Thus, these are called 3’-5’ phosphodiester bonds. During the polymerization of DNA, when a new nucleotide is added, a water molecule is lost through dehydration synthesis. The two strands run in opposite directions, known as antiparallel orientation. One strand has a 5’ end with a free phosphate group and a 3’ end with a free hydroxyl group (-OH). The other strand is oriented in the opposite direction having its 5’ end facing the 3’ end of the first strand and vice versa. Some critical features of a DNA strand are: Complementary Base Pairing: The nitrogenous bases in DNA form pairs through noncovalent hydrogen bonding, ensuring specificity in base pairing. Adenine (A) always pairs with thymine (T) through two hydrogen bonds, while cytosine (C) always pairs with guanine (G) through three hydrogen bonds. This complementary base pairing is the foundation of DNA’s ability to replicate accurately and transmit genetic information. According to Erwin Chargaff, the ratios of adenine (A) to thymine (T) and guanine (G) to cytosine (C) are equal.Base Stacking: The flat, planar structure of the nitrogenous bases allows them to stack on top of each other within the double helix. This base-stacking interaction stabilizes the DNA molecule and contributes to its structure and shape.Major and Minor Grooves: The base pairing along the helix forms grooves on the surface of the DNA double helix. These grooves are known as the major groove and the minor groove. They are critical in interactions with proteins that bind to specific DNA sequences and regulate cellular processes. DNA is necessary because it contains the instructions for an organism to grow and reproduce. Here are the essential functions of DNA: The primary function of DNA is to store and transmit genetic information from a parent cell to a daughter cell. DNA contains the instructions that determine an organism’s characteristics, such as its physical traits, behavior, and metabolic processes. These genetic instructions are passed from parents to offspring during reproduction, ensuring species continuity and trait inheritance. One of the most crucial functions of DNA is its role in protein synthesis. Proteins are essential molecules that perform various functions in cells and organisms. DNA serves as a template for synthesizing proteins through a two-step process: transcription and translation. During transcription, a segment of DNA is transcribed into a molecule called messenger RNA (mRNA) by an enzyme called RNA polymerase. The mRNA is further converted to proteins, a process called translation. Before a cell divides, it must duplicate its genetic material to ensure that each daughter cell receives an identical copy of the DNA. Copying parent cell DNA, called DNA replication, helps maintain its exact copies generation after generation. While DNA replication is remarkably accurate, errors can occasionally occur, leading to changes in the DNA sequence known as mutations. These mutations are the raw material for genetic diversity and evolution. Some modifications can be advantageous, offering new adaptations that confer survival benefits in specific environments. Others may be neutral or even harmful. Over time, the accumulation of beneficial mutations can drive the evolution of species, allowing them to adapt to changing conditions. Not all genes in a cell are active all the time. Instead, they are precisely regulated to respond to specific cues and signals. DNA plays a central role in gene regulation. Regulatory proteins and chemical modifications to DNA determine whether a gene is turned on or off. This regulation allows cells to differentiate into various types during development and adapt their functions to environmental changes, ensuring the coordinated operation of complex cellular processes. Article was last reviewed on Wednesday, September 13, 2023

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