

The Double Helix Answer Key

Name _____

DNA - The Double Helix

Recall that the nucleus is a small spherical, dense body in a cell. It is often called the "control center" because it controls all the activities of the cell including cell reproduction, and heredity. How does it do this? The nucleus controls these activities by the chromosomes. Chromosomes are microscopic, threadlike strands composed of the chemical DNA (short for deoxyribonucleic acid). In simple terms, DNA controls the production of proteins within the cell. These proteins in turn, form the structural units of cells and control all chemical processes within the cell.

Chromosomes are composed of genes. A gene is a segment of DNA that codes for a particular protein, which in turn codes for a trait. Hence you hear it commonly referred to as the gene for baldness or the gene for blue eyes. Meanwhile, DNA is the chemical that genes and chromosomes are made of. It stands for deoxyribonucleic acid. DNA is called a nucleic acid because it was first found in the nucleus. We now know that DNA is also found in organelles, the mitochondria and chloroplasts, though it is the DNA in the nucleus that actually controls the cell's workings.



In 1953, James Watson and Francis Crick established the structure of DNA. The structure is a double helix, which is like a twisted ladder. The sides of the ladder are made of alternating sugar and phosphate molecules. The sugar is deoxyribose. **Color all the phosphates pink (one is labeled with a "p"). Color all the deoxyriboses blue (one is labeled with a "D").**

Color the thymines orange. 
Color the adenines green. 
Color the guanines purple. 
Color the cytosines yellow. 

Note that the bases attach to the sides of the ladder at the sugars and not the phosphate.

The two sides of the DNA ladder are held together loosely by hydrogen bonds. The DNA can actually "unzip" when it needs to replicate - or make a copy of itself. DNA needs to copy itself when a cell divides, so that the new cells each contain a copy of the DNA. Without these instructions, the new cells wouldn't have the correct information. The hydrogen bonds are represented by small circles. **Color the hydrogen bonds gray.**

Messenger RNA

So, now, we know the nucleus controls the cell's activities through the chemical DNA, but how? It is the sequence of bases that determine which protein is to be made. The sequence is like a code that we can now interpret. The sequence determines which proteins are made and the proteins determine which activities will be performed. And that is how the nucleus is the control center of the cell. The only problem is that the DNA is too big to go through the nuclear pores. So a chemical is used to read the DNA in the nucleus. That chemical is messenger RNA. The messenger RNA (mRNA) is small enough to go through the nuclear pores. It takes the "message" of the DNA to the ribosomes and "tells them" what proteins are to be made. Recall that proteins are the body's building blocks. Imagine that the code taken to the ribosomes is telling the ribosome what is needed - like a recipe.

Messenger RNA is similar to DNA, except that it is a single strand, and it has no thymine. Instead of thymine, mRNA contains the base Uracil. In addition to that difference, mRNA has the sugar ribose instead of deoxyribose. RNA stands for **Ribonucleic Acid**. Color the mRNA as you did the DNA, except:

Color the ribose a DARKER BLUE, and the uracil brown. 

The Double Helix Answer Key: Unraveling the Secrets of DNA Structure

Have you ever stared at a complex diagram of DNA and felt a sense of bewilderment? Understanding the double helix structure is crucial for grasping the fundamentals of biology, genetics, and even medicine. This comprehensive guide serves as your "Double Helix Answer Key," providing a detailed explanation of the iconic structure, its discovery, and its significance. We'll unravel the intricacies of Watson and Crick's model, clarifying common misconceptions and providing you with the tools to confidently discuss this foundational concept. Prepare to unlock the secrets of life itself!

H2: The Discovery: A Race to the Finish Line

The story of the double helix is one of scientific rivalry and brilliant deduction. While many scientists contributed to piecing together the puzzle of DNA's structure, James Watson and Francis Crick are most famously associated with the discovery of its double helix nature. Their groundbreaking 1953 paper, published in *Nature*, revolutionized biology.

Their work built upon the contributions of several key figures:

Rosalind Franklin: Her crucial X-ray diffraction images, particularly Photo 51, provided critical evidence suggesting a helical structure.

Maurice Wilkins: A colleague of Franklin's, Wilkins shared Franklin's data with Watson and Crick, unknowingly accelerating their progress.

Erwin Chargaff: Chargaff's rules, demonstrating the equivalence of adenine and thymine, and guanine and cytosine, provided essential clues about base pairing.

The competition was fierce, with other teams, notably Linus Pauling, working simultaneously on the same problem. Watson and Crick's success stemmed from their ability to synthesize the existing evidence and build a model that elegantly explained the data.

H2: Understanding the Double Helix: A Structural Overview

The DNA double helix resembles a twisted ladder. Let's break down its key components:

Sugar-Phosphate Backbone: This forms the sides of the ladder, composed of alternating deoxyribose sugar molecules and phosphate groups. This backbone provides structural support.

Nitrogenous Bases: These form the "rungs" of the ladder. There are four types: adenine (A), thymine (T), guanine (G), and cytosine (C). A always pairs with T, and G always pairs with C via hydrogen bonds. This specific pairing is crucial for DNA replication and gene expression.

Base Pairing: The complementary base pairing (A-T and G-C) ensures that the two strands are antiparallel; they run in opposite directions. This antiparallel arrangement is vital for DNA replication and transcription.

Major and Minor Grooves: The twisting of the helix creates major and minor grooves along the surface of the DNA molecule. These grooves provide access points for proteins that interact with DNA, such as transcription factors.

H3: The Significance of the Double Helix

The discovery of the double helix wasn't merely an academic achievement; it had profound implications:

DNA Replication: The complementary base pairing allows for accurate DNA replication, ensuring the faithful transmission of genetic information from one generation to the next.

Genetic Code: The sequence of bases along the DNA molecule encodes the genetic information that determines an organism's traits.

Gene Expression: The information encoded in DNA is transcribed into RNA and then translated into proteins, which carry out the organism's functions.

Medicine and Biotechnology: Understanding DNA structure has revolutionized medicine, leading to advancements in genetic testing, gene therapy, and personalized medicine. Biotechnology relies heavily on manipulating DNA for various applications.

H2: Common Misconceptions about the Double Helix

Several misconceptions often surround the double helix:

DNA is always perfectly straight: DNA molecules are dynamic; they can bend, fold, and supercoil depending on their environment and function.

The double helix is the only form of DNA: While the B-form double helix is the most common, other forms, such as A-DNA and Z-DNA, exist under specific conditions.

Understanding the double helix automatically means understanding genetics: The double helix is the structure; genetics encompasses the broader study of inheritance, gene function, and variation.

H2: Beyond the Basics: Exploring Further

To truly master this subject, delve deeper into topics such as:

DNA Replication Mechanisms: Learn about the enzymes and processes involved in copying DNA.

Transcription and Translation: Understand how genetic information flows from DNA to RNA to proteins.

DNA Repair Mechanisms: Explore how cells maintain the integrity of their DNA.

Epigenetics: Investigate how factors beyond the DNA sequence can influence gene expression.

Conclusion

The double helix is more than just a beautiful structure; it's the fundamental blueprint of life. By understanding its intricacies, we unlock a deeper understanding of heredity, evolution, and the very essence of what makes us who we are. This guide serves as a foundation; continued exploration of related topics will further enhance your comprehension of this remarkable molecule.

FAQs

1. What is the diameter of a DNA double helix? Approximately 2 nanometers.
2. How many base pairs are there per turn of the helix? Roughly 10 base pairs.
3. What is the difference between DNA and RNA? DNA is double-stranded and uses thymine; RNA is usually single-stranded and uses uracil.
4. What is the role of histones in DNA structure? Histones are proteins that help package and organize DNA into chromatin.
5. How is DNA damaged, and how is it repaired? DNA can be damaged by various factors, including UV radiation and chemical mutagens. Cells have various repair mechanisms to correct this damage.

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genome and beyond. Watson's lively, panoramic narrative begins with the fanciful speculations of the ancients as to why "like begets like" before skipping ahead to 1866, when an Austrian monk named Gregor Mendel first deduced the basic laws of inheritance. But genetics as we recognize it today—with its capacity, both thrilling and sobering, to manipulate the very essence of living things—came into being only with the rise of molecular investigations culminating in the breakthrough discovery of the structure of DNA, for which Watson shared a Nobel prize in 1962. In the DNA molecule's graceful curves was the key to a whole new science. Having shown that the secret of life is chemical, modern genetics has set mankind off on a journey unimaginable just a few decades ago. Watson provides the general reader with clear explanations of molecular processes and emerging technologies. He shows us how DNA continues to alter our understanding of human origins, and of our identities as groups and as individuals. And with the insight of one who has remained close to every advance in research since the double helix, he reveals how genetics has unleashed a wealth of possibilities to alter the human condition—from genetically modified foods to genetically modified babies—and transformed itself from a domain of pure research into one of big business as well. It is a sometimes topsy-turvy world full of great minds and great egos, driven by ambitions to improve the human condition as well as to improve investment portfolios, a world vividly captured in these pages. Facing a future of choices and social and ethical implications of which we dare not remain uninformed, we could have no better guide than James Watson, who leads us with the same bravura storytelling that made *The Double Helix* one of the most successful books on science ever published. Infused with a scientist's awe at nature's marvels and a humanist's profound sympathies, DNA is destined to become the classic telling of the defining scientific saga of our age.

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of one semester or one quarter graduate courses in chemistry and biochemistry. In some cases the availability of texts in active research areas should help stimulate the creation of new courses.

CHARLES R. CANTOR New York Preface This monograph is based on a review on polynucleotide structures written for a book series in 1976.

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discovery of the twentieth century.

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generate ideas, collaborate to implement them, and build innovation skills throughout the organization to result in a competitive edge. This innovation advantage will translate into a premium in your company's stock price—an innovation premium—which is possible only by building the code for innovation right into your organization's people, processes, and guiding philosophies. Practical and provocative, *The Innovator's DNA* is an essential resource for individuals and teams who want to strengthen their innovative prowess.

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2013-12-15 This unique look at the study of DNA goes beyond the science and explores the lives of four great scientists: James Watson, Francis Crick, Maurice Wilkins, and Rosalind Franklin. It was through their complex personal interactions and their devotion to the science that led to breakthroughs surrounding the structure of DNA and our modern understanding of genetics. Readers can learn that science is not about one individual and his or her discoveries, but is the work of many. Numerous scientific breakthroughs can be attributed to competition and rivalry.

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fundamental and practical aspects of the subject have been covered by solved questions. This book meets the challenging requirements of CSIR-NET, GATE, IARI, BARC and Ph.D entrance of various Indian universities.

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