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THE DOUBLE HELIX

This plate illustrates the double helix structure of DNA proposed by Watson and Crick and widely accepted today as correct. To allow a better view of the parts of the molecule, the spaces between base pairs has been greatly exaggerated. The upper end of the illustration is highly diagrammatic and shows the overall relations of the parts, while the lower portion shows the structural formula with all of the individual atoms and their bonds.

Color the headings Simplified Structure and Uprights/Backbone, titles D and P, and the associated structures in the upper portion of the plate. Use light colors for D and P.

The structure of the DNA molecule is often compared to that of a ladder that has been twisted. The *deoxyribose* and *phosphate groups* alternate continuously the whole length of the molecule and form the "uprights" of the ladder (sometimes called the "backbone").

Color the heading Rungs/Base Pairs, titles A, T, C, G, and H, and their associated structures in the upper portion of the plate. Use light colors for A, T, C, and G.

The base pairs occupy the position of the "rungs" of the ladder, although in the actual molecule they are tightly packed on top of one another as no ladder rungs ever would be. The particular sequence of the four different bases constitutes a "code" in which specific hereditary information is recorded. The method by which that code is translated to specify the exact sequences of amino acids to be used in making the cell's proteins will be covered in the next few plates.

The helix shown here, called the "B-form," is the most stable and therefore the most common structure for DNA. In recent years it has been discovered that local regions of DNA may form a slightly more open helix, called the A-form, and in some cases a very different, left-handed helix, called the Z-form. (The significance of these alternate forms is not known.)

The average length of DNA in a human chromosome is about 140 million base pairs, or 14 million turns of the helix. If laid out in a straight line, it would be about 4.8 centimeters long (just under 2 inches).

Color the heading Structural Formula and the remainder of the plate.

The structural formula shows more clearly which atoms are attached to which. Those details may or may not be important to you, depending on your reasons for studying this plate, but they are important to the cell because any deviation will result in some kind of mutation or even the death of the cell.

To clarify the exact interconnections of the various atoms, this view shows the base pairs and the ribose subunits rotated 90 degrees from their actual orientation in the molecule. You will note that each base is attached to carbon number 1 of its deoxyribose molecule. To facilitate discussions of the structure of DNA, this carbon atom is designated as carbon 1′ ("one prime") to distinguish it from the carbon atom number 1 of the base. The phosphates, then, are attached to carbons 3′ and 5′.

Note also that the directions of the sugar and phosphate uprights or backbones are "antiparallel"; that is, the chain on one side runs in the opposite direction to the chain on the other side. On one side, the 5′ carbon of each ribose connects by way of a phosphate group to the 3′ carbon of the ribose above. On the other side, the 5′ carbon of each ribose connects by way of a phosphate group to the 3′ carbon of the ribose below. Thus the chains progress in the direction 5′ to 3′ up the helix on one side and 5′ to 3′ down the helix on the other side. At each end of the DNA molecule, then, one strand will end with a 3′-OH and the other will end with a 5′-phosphate.

In 1958 Watson, Crick, and Wilkins received the Nobel Prize in physiology and medicine for this discovery of the structure of DNA. It was an extremely important achievement because, as Watson and Crick pointed out in their paper announcing the discovery, not only could such a structure carry genetic information coded in the varying sequence of the bases, but there was also an obvious mechanism by which the molecule could be self-replicating, so that exact copies could be supplied for each daughter cell in cell division.

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SIMPLIFIED STRUCTURE★
UPRIGHTS/BACKBONE★
DEOXYRIBOSE D
PHOSPHATE P
RUNGS/BASE PAIRS★
ADENINE A
THYMINE T
CYTOSINE C
GUANINE G
HYDROGEN BOND H

STRUCTURAL FORMULA★